JULY, 1938

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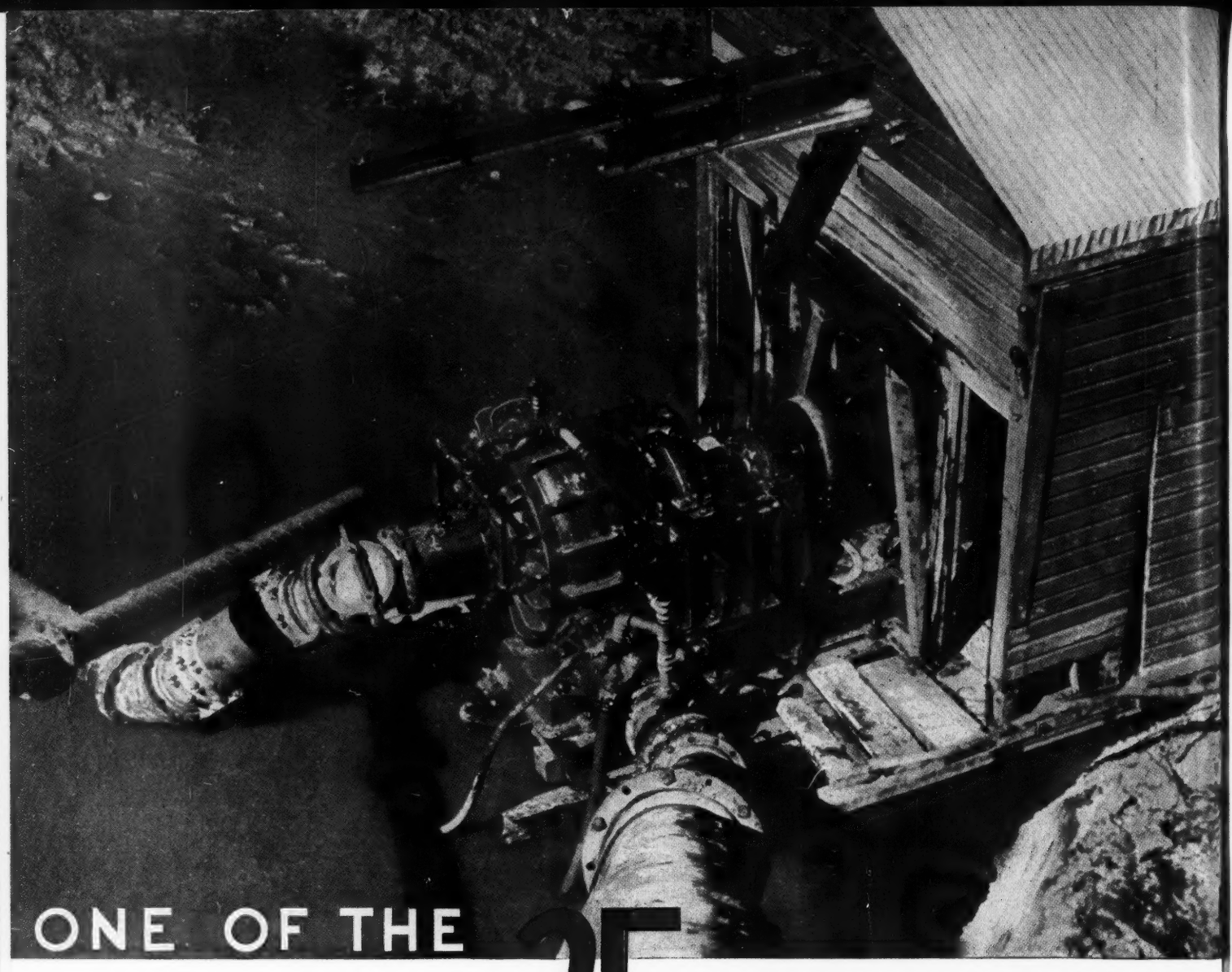

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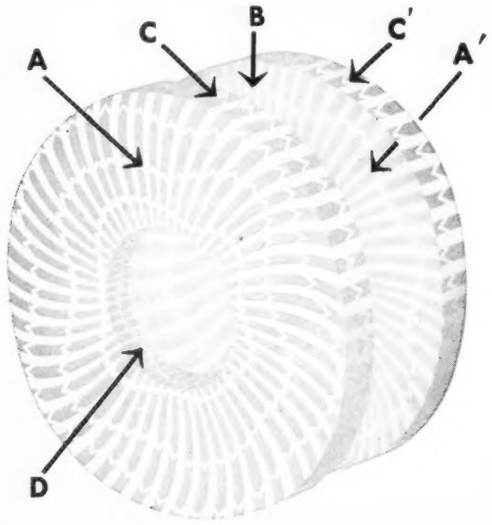

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Next Month

FOLLOWING OUR CUSTOM of devoting one issue annually to the activities of a single mining enterprise, or to an area famous for its mining industry, *Engineering and Mining Journal* for August, 1938, will tell the story of American Zinc, Lead & Smelting Company. A series of articles by the company's technical staff will describe its mining, milling, and metallurgical operations in the Tri-State district and in the States of Washington, Illinois, and Ohio. This will be the eleventh special issue of this character, eight of which have dealt with individual companies in the United States, Canada, and Mexico. The three others described the mining industry of California, Colorado, and the Philippine Islands. These special issues have received generous commendation because they concentrate between their covers a more complete view of a company, its related activities, and its management than could otherwise be obtained. Further, because of the diversity of interests of a large enterprise, some phase of its operations is certain to serve a useful purpose to each reader, whether his taste be for mining, metallurgy, or geology. The August issue should fulfill this expectation.

Some Butte Facts

MURL H. GIDEL, of Anaconda's geological department at Butte, has reduced the metal output of that famous camp to terms that are striking, even to those who know something of the district. Its production of more than 11,173 million pounds of copper would form a cube 272 ft. on edge. In addition, its yield of zinc, now over 2,857,400,000 lb., would make a 186-ft. cube, approximately; and its lead and silver, though considerably less, cubes respectively 80½ ft. and 37¼ ft. in each dimension. The figures for these three metals are highly respectable for a copper camp. Gold also, sufficient for almost a 5-ft. cube, has been produced. The tonnage of copper, zinc, and silver ore, mined to date, is equivalent to a cube 1,137 ft. on edge. Placed beside this the Empire State building, though somewhat higher by virtue of its "mooring mast," would look almost insignificant. Of all this there is no visible suggestion to one standing in Butte today, save the town itself and its many headframes. Bingham has its terraced mountain, and, on the Mesabi, Hibbing its enormous open pit, to bear witness to the tonnages taken out. In Butte, as in many other famous areas, one must go underground for evidence, aside from figures. Nevertheless, it is the tonnage that remains rather than the magnificent performance of the past that holds the interest. With great possibilities still at depth, especially as the problems of deeper mining are steadily yielding to solution by its engineers, Butte needs only a fair price for its metals and continued cooperation of labor with management to give a livelihood to its thousands of miners, with their dependents, for years to come.

Butte a year ago presented a picture of intense activity—in strong contrast with today, when its mines save one or two are shut down temporarily until the copper surplus is more in keeping with demand. The recent advance in price, unexpected as it was, will be encouraging. Perhaps the mines that so recently ceased hoisting ore will be resuming sooner than was expected.

Nichols Becomes Phelps Dodge

FORMAL ANNOUNCEMENT was made on July 1 of the change of name of Nichols Copper Company to Phelps Dodge Refining Corporation. Thus a name long and favorably known in the smelting and refining of copper passes into the history of the industry. The change was logical enough. Nichols had long been a refiner of copper for Phelps Dodge. Ten years ago the latter acquired an interest in Nichols, and by 1930 is reported to have owned

most of the outstanding shares. So Nichols had for some time been a Phelps Dodge property in everything but name, and the announcement makes clear that "this represents a change of name only, and will not affect its management, personnel, or business relations."

Nichols Copper Company was incorporated in 1905, successor to Nichols Chemical Company. At its Laurel Hill works, on Long Island, New York, it conducted an extensive smelting and refining business, treating ore, matte, and blister copper on a custom basis. At one time it had the largest electrolytic refining plant in the world, with a capacity of 45,000,000 pounds of copper per month. It enjoyed a deservedly high reputation for the purity of its product and the efficiency of its metallurgical practice, with which the name of Herreshoff must be closely linked. Nichols and Herreshoff made history in the American copper industry. Their reputation will be fittingly perpetuated under the illustrious name of Phelps Dodge.

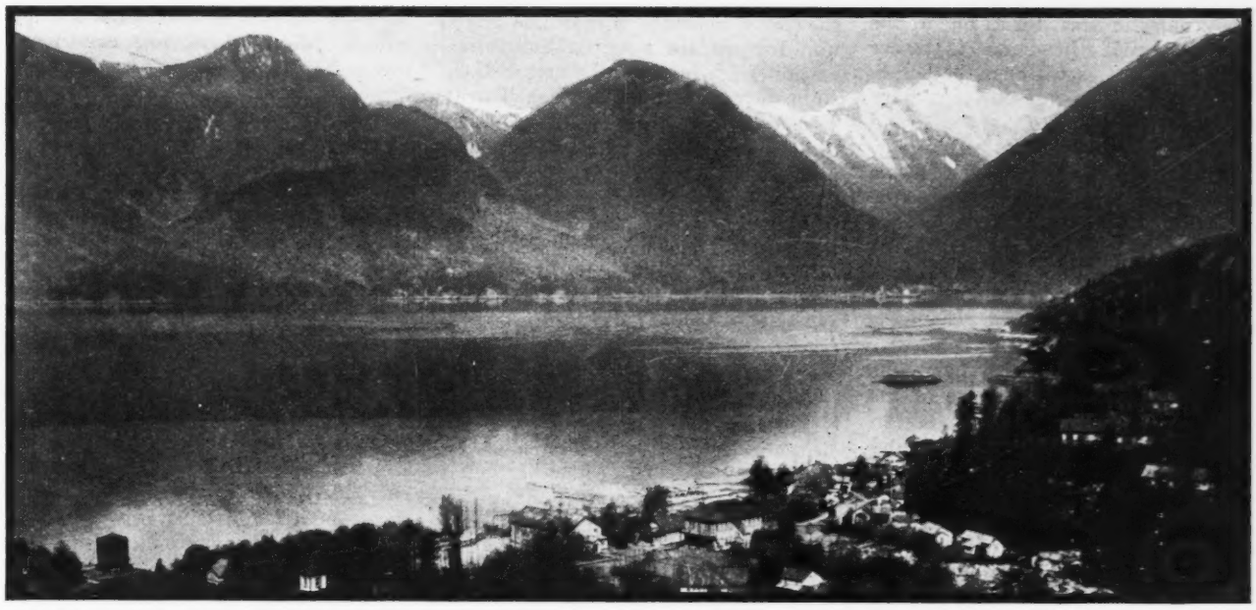
Reversal of Trend

NO ADEQUATE EXPLANATION has yet been made for the sharp reversal of trend in the securities market that occurred on June 20. Economists and financial writers, exhausting a long list of possible reasons ranging from the adjournment of Congress to the hurried trip home of Ambassador Kennedy, finally agree that there is no single or multiple reason for what happened. Why should a group of men leave their business one Saturday—a business that had been in the doldrums for weeks—and return the following Monday to start a spurt of activity that continued feverishly and almost unchecked for two weeks? And yet that was the fact. The rise from June 20 to July 2 was far more precipitous than the decline of 1937, and was paralleled only by the hectic week before the collapse of 1929. If June 20 ultimately marks the beginning of recovery it will be an unusually sharp and recognizable turning point.

Commodities promptly followed securities, and prices rose sharply as buying volume increased. Non-ferrous metals shared the rise. Copper lagged behind lead and zinc; not that a higher price was not justified but that it seemed impolitic to raise the price in the face of recent closing of mines and curtailment of production. Consumers, nevertheless, recognized the situation and came into the market in anticipation of an inevitable price rise. Consequently sales of copper for June amounted to 87,618 tons, larger than for any month since December, 1936, an eighteen-month record. June sales of lead and the common grades of zinc were also higher than for the past nineteen and nine months, respectively. Inventories in the hands of consumers were evidently low, to cope with a trade revival, and they lost no time in replenishing stocks at low prices. So June closed and July opened on an optimistic note, with each of the major non-ferrous metals enjoying a price rise of one-half cent or more at a time when all signs pointed to a quiet summer.

Although it may be futile to speculate on the reasons for the recent turn in business sentiment, a few fundamental economic and political factors are worth recording as long-range inflationary influences. First is the reversal of the Government's monetary policy. Last year was marked by credit contraction, sterilization of purchased gold, and increase of bank reserves. In 1938, by contrast, gold was desterilized, credit was expanded by bank loans to the Government and by Treasury expenditure, and bank reserves were reduced. Coupled with these influences was the spending policy of the late lamented Congress, which must of necessity supply artificial stimulation to business. Hence the swing of the pendulum was indicated, even if the time and magnitude of the movement could not be exactly foreseen.

Less immediate emphasis, we believe, is to be placed on the repeatedly rumored devaluation of the dollar and corresponding increase in the price of gold. The rumor will not down in spite of official denials, and some economists still accept those denials with mental reservations. Nevertheless, we are confronted with the fact that a glut of gold is being produced at $35 per ounce. Why raise the price? World gold production has broken all records for several successive years, and 1938 promises to repeat the performance. South African production was more than one million ounces in May, and nearly five million for the first five months. Ontario likewise set a record in May. In fact, May was the record month in 1938 for world gold production, which showed an average increase of more than 100,000 ounces per month over the corresponding period in 1937. Production of such increasing magnitude is of itself inflationary, and needs no price encouragement. Offsetting such logic is the fact that our country has a managed currency, that vast monetary powers are still lodged in the Executive, and that political expediency might dictate actions otherwise unaccountable. But leaving further currency manipulation out of consideration, it seems likely that the pendulum has swung away from deflation, and that powerful expansionary forces will be at work during the remainder of the year.



OCEAN-GOING VESSELS enter fjord-like Howe Sound and are loaded with copper and pyrite concentrates for shipment to Tacoma

Producing Copper At Britannia Beach, B. C.

Diversified mining methods are employed and mill practice requires removal of slime by washing, followed by flotation

John B. Huttl
Assistant Editor

BRITISH COLUMBIA'S premier copper-mining enterprise—the Britannia property of the Howe Sound Company—is at Britannia Beach, on Howe Sound, some 30 miles by boat from Vancouver. The trip is made on comfortable boats operated by the Union Steamship Company, and requires nearly three hours, including stops at Bowen Island, a well-known summer resort, and other camps along the way. The topography of the Sound area is rather rugged; in fact, it reminds one of the fjords of Norway, with the heavily wooded Coast Range Mountains rising precipitously to heights exceeding 6,500 ft. Water depths of the Sound and improvements made in recent years in the channel at Britannia Beach landing are such that ocean-going vessels can load and discharge cargo directly at the pier. Climatic conditions vary little from those prevalent in the Northwestern coast regions.

Copper was found in the Britannia district by Dr. A. A. Forbes as early as 1888. In 1898 Oliver Furry relocated the five original claims now known as the Britannia mines and interested Boscowitz & Company, fur traders of Victoria, B. C. Two years later a group of Vancouver business men and Howard Walters, of Libby, Mont., organized the Britannia Copper Syndicate, Ltd., and purchased a 7-10ths interest from the Boscowitz company. In 1902 George H. Robinson, of Butte, Mont., bought out the holdings of Walters and acquired a controlling interest in the syndicate, including the remaining 3-10ths interest from Boscowitz, and in 1903 reorganized the Britannia Copper Syndicate, increasing the capitalization. The stock was underwritten by Captain Stern, of New York, who interested G. B. Schley in the financing of the enterprise. The following year extensive development of the mine was started and a 200-ton concentrator and an aerial tramway were erected.

The mines entered the lists of active copper producers in 1905, and shipments of ore and concentrates were made to the smelter at Crofton, on Vancouver Island. In this year G. B. Schley organized the Britannia Smelting Company, Ltd., which took over the holdings of the Northwestern Smelting Company, Ltd., at Crofton. The name of the company was subsequently changed to Britannia Mining & Smelting Company, Ltd. (1908), and the entire control of the Britannia Copper Syndicate, Ltd., purchased. Since then claims were added either through purchase or location, until today the company holds some 500 claims, comprising more than 25,000 acres, with the property representing an investment of $10,000,000. E. B. Schley, the son of G. B. Schley, is chairman of the board of Howe Sound Company; W. J. Quigly, president, H. H. Sharp, vice-president; and C. P. Browning, general manager of both the Britannia operations and the Chelan Division at Holden, Wash.

As already pointed out, the property is a consolidation of several mines—namely, Jane, Bluff, East Bluff, Fairview, Empress, and Victoria. Current production is obtained from the Bluff, East Bluff, Fairview, and Victoria.

The Britannia section, which is about 7 by 2 miles in area, forms one of the numerous roof pendents that are found in the Coast Range batholith. The rocks are chiefly greenstones, dark carbonaceous slates, slaty tuffs, and pyroclastics of early Paleozoic age. These rocks were intruded by feldspar porphyry sills and dikes and by the Coast Range batholith of Jura-Triassic age. The rocks in the Britannia area have a general east-west strike which is parallel to the long axis of the roof pendent.

Most of the orebodies are lenticular in shape and lie in a major shear zone that follows the general strike of the formation. The several orebodies in this section vary greatly in length and width, and in the degree of silicification, which has accompanied or slightly preceded the vein forming period. Chief copper mineral is chalcopyrite, which is accompanied by pyrite. Chalcocite, covellite, bornite, native copper, argentite, tetrahedrite, sphalerite, and galena make up a small and varying percentage of the ore shipped to the mill. A small amount of gold and silver is found in most of the veins, and the chief gangue minerals are quartz, gypsum, anhydrite, calcite, and barite.

The mines are about 3 miles from the concentrator on tidewater, and a general layout of the underground workings is shown in Fig. 1. As will be seen, development consists chiefly of adits and underground shafts. The 2,700 and 4,100 levels are the main haulage levels, with the latter being extended to handle all ore mined below the 2,700 level. Supplies for the Empress and Barbara are handled through No. 1 shaft, which measures 18 ft. 8 in. by 9 ft. 6 in. in section and contains three compartments. The two hoisting compartments are 7 ft. 6 in. by 6 ft. in the clear. No. 2 shaft in the Victoria mine has two hoisting compartments, each 5 ft. by 4 ft. 6 in., and a manway 4 ft. by 5 ft., and extends from the surface to a sump 31 ft. below the 3,500 level. The other four shafts in the Fairview and Bluff mines are smaller, the No. 4 shaft being sunk on a 58 deg. incline to prospect the ground below the 2,700 level.

Exploration

Exploration is done by drifts, crosscuts, and raises, the different shafts serving as centers for such work. In addition, diamond drilling is carried on on the surface whenever geological investigation justifies such a procedure, and from exploratory headings, especially from those driven in the footwall section of the wide Bluff orebody. Here, the holes are drilled at right angles to the strike of the orebody to determine the limit of commercial ore that forms the hanging wall. Drilling equipment available at the mine includes a gasoline-driven unit for surface work; a Sullivan C machine, 1⅞-in. core; Longyear U.G., ⅝-in. core; and a small Mitchell drill, ⅛-in. core. All drills operating underground are driven by air, and bortz bits are used exclusively.

Exploratory drifts and crosscuts in general are advanced 5x7 ft. in section, with one machine employed. While drilling and blasting the 14-hole round is done by one man, two men are allowed for mucking, which is carried out on a separate shift whenever possible. Advance per shift ranges from 3½ to 5 ft. Work in the 6x3½-ft. powder drifts used in the Britannia mining method proceeds on all three shifts. The 13-hole round is drilled over the rock pile from a crossbar and daily advance averages 2¼ to 3 ft., depending on the hardness of the ore. Broken rock is removed by wheelbarrow for distances up to 75 ft., and by ¾-ton cars running on 12-lb. rails when longer haulage is involved. In the secondary haulage drifts, 8x8 ft. in section, a 21-hole round is used. Drilling is done with two machines on a crossbar.

New Haulage Tunnel

The 4,100 level haulage tunnel has reached a point just under 14,000 ft. from the portal. Near the present face, which will later be extended possibly to a point near the Victoria shaft, a new rock raise is being driven to the 2,700 level. This raise will have three control chutes for ore withdrawal. The crusher will be installed on the 3,900 level, and the ore therefrom will be drawn from a new chute, whence it will be trammed to the mill bins. The 4,100 level tunnel is 10x12 ft. in section and has a large ditch on one side to provide adequate drainage should the workings below the 2,700 level open up a large flow of water. Four 4-in. machines mounted on a jumbo of conventional design have been used in driving the tunnel. The machines are equipped with special shells to facilitate making a 2-ft. change in soft ground. An average round consists of 32 or 34 holes, depending on the type of ground being drilled. Holes are drilled sufficiently long to give an average break of from 7 to 8 ft. Except in very hard ground, 40 per cent gelatine powder, No. 6 caps, and standard fuse are used.

Broken rock is removed and loaded into 120-cu. ft. side-dump cars by an Osano-type scraper slide. The hoe-type scraper fitted with a detachable manganese-steel lip is actuated by a 35-hp. Sullivan hoist. It is 42 in. wide and has an actual loading rate of 2 tons per minute. An 8-ton Westinghouse locomotive is used for switching operations, and a 15-ton G.E. unit for hauling loaded cars to the waste pocket on the 4,100 level. The working crew on each shift consists of four miners, two muckers, one motorman, one brakeman, and a shift boss. In addition, there are employed on the day shift a trackman and helper, a ditchman, two timbermen, and an operator and helper for sharpening steel in the special shop at the portal of the tunnel.

Several types of raises are used in the mine. In narrow veins such as encountered in the Empress and Victoria mines, all raises are timbered and contain a chute lined with 4-in. planks, and a manway. These are separated by a row of stulls on 5- to 7-ft. centers. A strong bulkhead covers the manway. Just below the bulkhead a chute plank is left out to facilitate entrance to the face and allow smoke to escape after blasting, which is generally done at the end of the shift. In general, the raise is advanced 20 ft. above the bulkhead before the stulls, chute, and bulkhead are raised, and staging rests on round sprags from 4 to 6 in. in diameter. Waste or rock raises are carried with cribbed manways in several parts of the mine. This method is speedier and less costly for the reason that the framed timber, which can be reclaimed later, need only be placed and spiked, in contrast to the divers timbering operations required in conventional practice.

Standard cribbing is 6x10 ft. on edge and 3 ft. 6 in. in the clear, which is used also for the cribbed manways in the filled rill stopes. Raises in hard ground generally are untimbered. Usually, they are driven from a bull-doze chamber at 50 to 57 deg., with the broken rock flowing back to the chamber. Bulkheads covering half the raise are placed each 50-ft. advance. The ladders used in this work are made from 3x4-in. fir with 1-in. pipe rungs over ¾-in. rods. In the raise they are held in place by U-shaped brackets made from old drill steel.

Mining Methods

The different mining methods employed in the mines are selected on the merits of each individual block of ore to be mined. These include surface glory holes, shrinkage stoping, shrinkage with powder drifts for primary breaking, horizontal cut-and-fill, horizontal square-setting, open rills, and the Britannia method of mining, a large-scale retreating shrinkage system frequently combined with powder drifts for primary breaking, evolved by C. V. Brennan, assistant general manager.

Square-set mining and cut-and-fill rill stopes are principally employed in the Empress and Victoria mines, where the veins are fairly narrow, the walls generally weak, and the ore itself often blocky. Here, the veins range from one to six sets in width. The

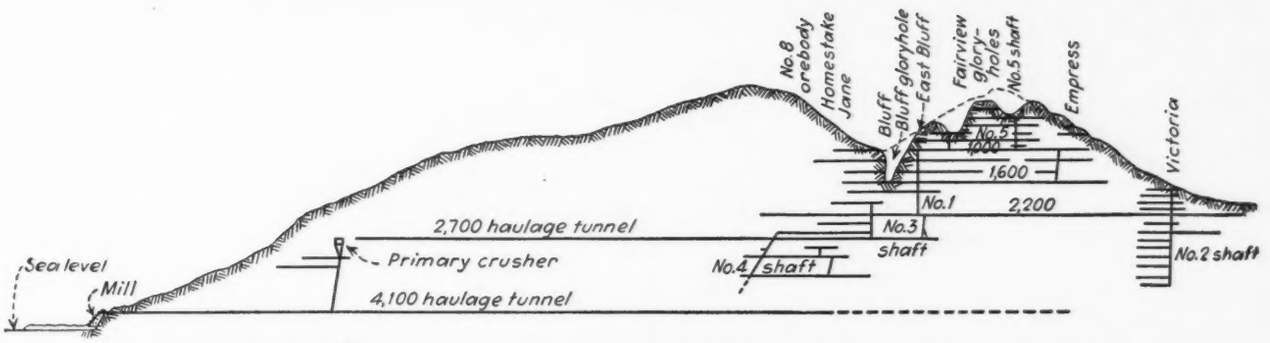


Fig. 1 . . . GENERAL VERTICAL PROJECTION of the underground workings, location of shafts, and main haulage levels in relation to sea level. Extension of the 4,100 haulage level is now under way to handle all ore mined below the 2,700 level

floors are spaced at 7-ft. 6 in. intervals, with posts on 6-ft. centers both ways. Posts and caps are made from 10x10-in. timber, and the girts from 6x10-in. material. All chutes are spaced at 36-ft. intervals longitudinally with the manway in the adjoining set.

To reduce shoveling to a minimum, rock slides are run to the chutes. The ore is mined in sections 48 ft. long, four floors being alternately mined and filled until the upper limits of the stope are reached. As in the case of broken ore, waste filling is done by means of rock slides. Machines are set up ahead of timbers, and the round is blasted onto the mucking floor below. Ore withdrawn from the chutes is trammed in 22-cu. ft. cars, one trammer handling from 30 to 60 cars per shift. Stope crews in general consist of a miner, timberman and helper, and two muckers.

In cut-and-fill rilling, the holes are drilled from the rill toward the chute at minus 20 deg., with from 15 to 20 ft. of ground being removed at a time above the filling. The last face in each bench is drilled but not shot, which saves considerable time and trouble when starting a new section. The crib chutes are made from 10x10-in. timber, measure 4 ft. 6 in. in the clear, and are built up as mining advances. The adjoining crib manways are identical in size with those used in the rock and waste raises discussed previously. Filling is a matter of importance. Current practice is to mine but a moderate portion of ground at one time, because the excessive time required for filling large openings usually results in badly opened up walls and consequent loose filling. Subsequent settling, in turn, increases maintenance costs for sill timber and track on levels above.

Besides the waste obtained from development work filling is received from surface glory holes that draw glacial material composed of clay, sand, and boulders. All rock at Victoria is covered by this material to a depth from 100 to 150 ft. Two glory holes are used, one at each end of the mine. These feed into raises that extend to the lowest underground workings. A bulldoze chamber is situated on each raise just below the surface. The material passes through grizzlies made from 100-lb. rails spaced 10 in., the relatively small opening assuring easy drawing conditions below. All chutes on levels below the 2,200 level are equipped with arc gates through which the waste can either be bypassed to the level below or be drawn directly into 22 cu. ft. cars and trammed to an empty stope. Both operations are done by means of a long removable lip.

Large Shrinkage Stopes

Shrinkage stoping is practiced principally in the Fairview mine. Two methods are used—namely, large-scale shrinkage operations for extracting ore remaining in the upper levels, and conventional shrinkage stopes for mining orebodies of moderate size on the lower levels. In the latter stopes, the chutes are placed on 33-ft. centers, and before actual stoping is started a raise is advanced to the level above (200 ft.). A narrow pillar is left around the raise to serve as a manway while stoping is in progress. Raises are driven east and west from each chute and connected. Service is mostly through a chute at one or both ends until the center of the stope is too high to permit entry from the bottom, when service is transferred to the raise. At the start, the stopes are carried up in the manner of a rill stope, the practice being changed to flat-back form as soon as service is entirely from the top. The method has proved satisfactory in every way.

Large shrinkage stopes were made in the Bluff orebody, which is from 50 to 200 ft. wide. The practice here was to take a cut along the footwall, leaving a belly to the hanging wall, which was blasted down with a small number of long holes. Most of the ore thus brought down was too large to be drawn through available chutes and had to be reduced to proper size by secondary drilling and blasting. Later, when stoping operations were started at greater depths, especially in the western extension of the Bluff orebody, in which the ground does not stand well, it became dangerous to enter the stope to plug large boulders. To obviate these conditions, bulldoze chambers with grizzlies were introduced at the draw points. Subsequently, this method was superseded first by a modified Latouche mining system and later by the Britannia method of mining, to be described.

This method as applied to the East Bluff orebody is graphically shown in Fig. 2. Here the orebody extended from below the 1,200 level to the surface at about the 700 level and east of the old Bluff glory hole. The 850 and 1,000 levels are intermediate levels. Briefly, the scheme of operation includes (1) establishment and development of a bulldoze-chamber level, (2) complete undercutting of a section of the orebody, (3) development of block for use of powder blasts, and (4) control of ore drawing. The bulldoze chambers are spaced at intervals of from 40 to 70 ft., and each is provided with a safety chamber. Grizzly rails are made up of three 100-lb. English "Bullhead" section rails held together by two $1\frac{1}{4}$-in. bolts. Spacing varies from 26 to 36 in., depending on the kind of ore mined.

Fig. 3 shows a typical bulldoze chamber. In preparing the block for mining, a series of transfer raises with branch wings are driven from the auxiliary haulage level to serve bulldoze chambers situated one, two, and even three levels above (intervals about 200 ft.). The main raises are carried on through, and the wing raises are advanced from points on the main raises to connect with the bulldoze chambers used as draw points on the different levels. In general, the untimbered raises are driven at 55 deg. with a 6x9-ft. section.

Stope preparation consists of driving raises at 45 deg. from the bulldoze chambers until they intersect one another. The raises are enlarged to form a small shrinkage stope, from which broken material can be drawn into the underlying bulldoze chambers. These stopes in time merge into one another and thus form the block to be mined. From this stage, breaking is done by the Britannia method.

The burden that can be given to the

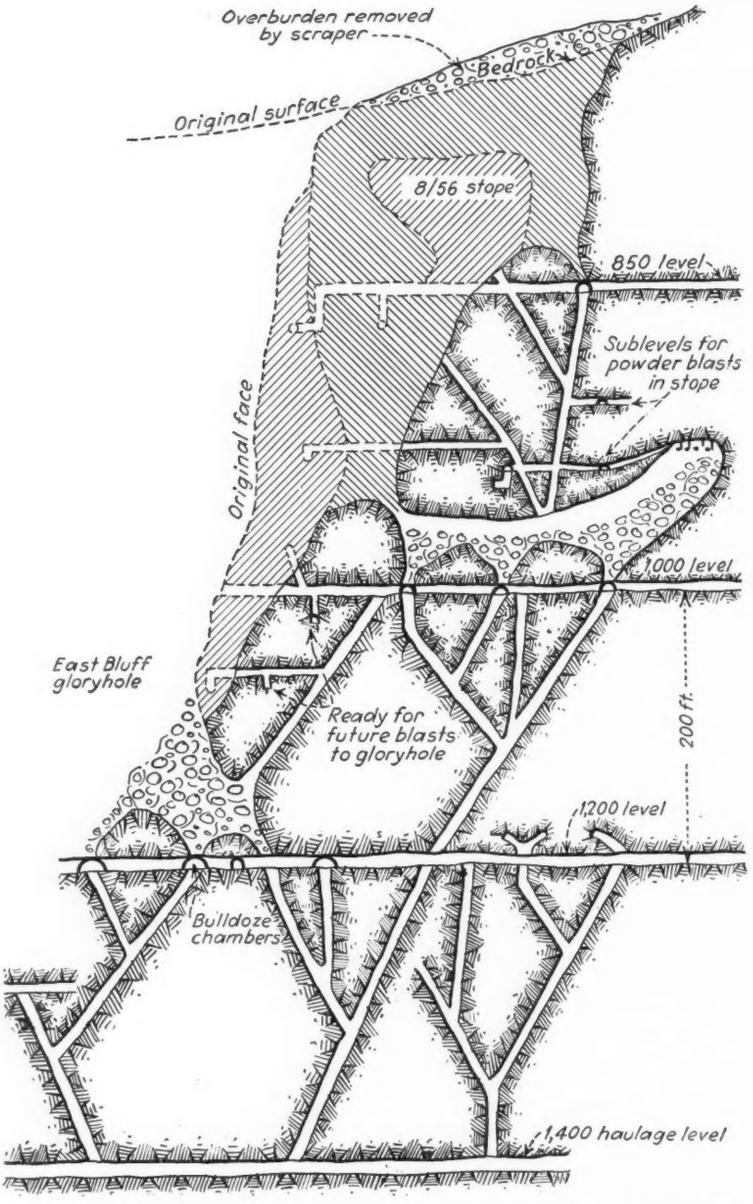


Fig. 2 . . . BRITANNIA MINING METHOD is a system applied to the East Bluff orebody as shown above, which includes a bulldozer chamber level, some undercutting, development for large powder blasts, and ore removal control

powder varies from 25 to 40 ft., depending on the width of the undercut, the hardness of the ore, and the strength of the wall rocks. In general, the powder workings are reached from the raises and winzes driven to serve the bulldoze chambers. If drawing has not been completed on the level above, a raise is driven from the back of the shrinkage stope to this level, or occasionally a short raise may be driven from the back of a new bulldoze chamber to reach the elevation of the first powder blast.

The powder drifts, called coyote drifts, are driven 6x3½ ft. in section. A crew consists of a miner and a mucker, who muck, drill, and blast a round each shift. As the ore zone is cut by the various bulldoze chamber ring raises, especially as the level is reached, the coyote drifts are seldom more than 75 ft. in length, which allows the use of wheelbarrows. In longer coyote workings a ¾-ton car is used on 12-lb. rails set at 18-in. gage. From the end of the coyote drift or crosscut a winze is sunk, and from the bottom of this winze two "toes" are driven to make a good pocket for the powder. The "toes" vary in length between 10 and 20 ft., and are about 3x3 ft. in section for the last 6 or 8 ft. The depth of the winze depends upon the burden to be given the powder, an average being 10 or 12 ft. A winze assures complete and tight tamping, for after loading it as well as the "toes" are filled with damp, fine ore. The material broken in the last few rounds is mucked back and saved for this purpose.

Gelatine powder is used, the strength varying with the hardness of the ore. Although 100 per cent powder has been used, 40 per cent is now the standard. This powder is received in cases containing four 12½-lb. bags. This practice was originated at Britannia and lessens the trouble of loading. Cordeau is run from toe to toe and a No. 6 detonator placed on each end. Another detonator is placed in each pocket, making a total of four detonators for the two "toes." Four 50- or 60-ft. fuses are used for a single pair, but when more than two toes are detonated simultaneously, electric caps are employed.

On completion of undercutting operations, the back of the stope is blasted down in horizontal layers from 25 to 30 ft. thick. Broken ore is drawn off through the bulldoze chambers in the conventional manner. The method described can be modified to fit conditions in the original planning of the stope as well as being adapted to suit the changing conditions encountered as mining progresses. By retreating constantly into virgin ground, no permanent pillars need be left and the risk of injury from falls of ground is considerably reduced. Mining costs are very low, amounting to about 23.5c. per ton, excluding development and tramming.

Glory-hole mining in the Bluff and Fairview mines was originally done by a system of benching. Tripod machines and pluggers were employed in drilling operations. Working benches were 3 ft. or more in width, and the broken ore was drawn through bulldoze chambers into transfer raises. Current methods are those of quarrying; that is, coyote-hole blasting is being applied, with the ore handled by gravity through bulldoze chambers into a rock-raise system as previously. In the East Bluff section from 25,000 to 50,000 tons of material are broken by one shot, and in the Fairview mine as much as 150,000 tons have been broken at once.

Drilling equipment is chosen after thorough test to suit the Britannia conditions. Machines now in use are furnished by the Chicago Pneumatic Tool Company, Ingersoll-Rand, Holman, Gardner-Denver, and Sullivan Machine Company. Most of the drifting and stoping are done with 3½-in. machines, but in very hard ground and for drilling in the 4,100 level tunnel the 4-in. machines are used. The greater part of the stopers employed are 3-in. units, and save for a few used occasionally by timbermen for cutting hitches, all are self-rotating. Pluggers are mostly of the dustless type for work in the bulldoze chambers, though the common type of wet machines are used for sinking shafts and winzes. All drills are made from 1-in. hexagonal steel. Lugged shanks, which tests show to be from 12 to 15 per cent more efficient than the anvil-

block type, are used on all Leyner machines. The pluggers are equipped for collared shanks. Except on the jumbo, where 4- and 5-in. arms are used, all machine arms are made from 3-in. extra-heavy pipe, their length varying from 18 to 30 in.

Blasting

Many types and grades of powder are employed in blasting. For development 40 per cent gelatine powder is used, and in hard ground 60 per cent gelatine for the cuts; on Fairview and West Bluff bulldoze chambers, 30 per cent gelatine; Victoria and Empress square-sets, 30 per cent ammonia forcite; 40 per cent gelatine in the Victoria cut-and-fill rill stopes and all East and West Bluff stoping; 40 and 60 per cent gelatine for powder blasts; and 100 per cent nitroglycerine for special work. Both conventional and electric blasting is practised.

More than half of the daily output of 7,000 tons passes to the 2,700 level through a single rock raise, known as No. 68, which contains control chutes at the 2,200, 1,800, and 1,200 levels. A branch raise from the 2,700 level serves as an auxiliary drawing point, and both chutes are connected by a circular track. As much water is encountered during the rainy season (spring and fall), special precautions against spills are necessary. The chute proper is made of monolithic reinforced concrete and employs a special finger gate comprising three 17-in. fingers, each being controlled by an individual overhead air cylinder. The fingers are built up of three 90-lb. rails covered with steel plate, and each unit weighs 1,700 lb. They may be operated together or singly. Withdrawal of sticky material is speeded up by air and water jets introduced under the chute bottom, and the flow of fine ore is stopped by an upward cutting "sandboard" situated just below the end of the fingers. The sandboard is operated by a 28-in. air cylinder.

On the other 2,700 level chutes, nearly all secondary transfer chutes, and on control chutes, two-rail fingers are used. The fingers are attached to a bridle actuated by a single cylinder. Chute lining consists of 1-in. plate for the sides and 4-in. cast-steel slabs for the bottoms. These are cast at the company foundry and measure 36x55 in. Caps are made from 14x16-in. timber covered with 1-in. plate. On main control chutes in the No. 68 system, caps are built up of I-beams and faced with detachable 3-in. cast-steel wearing face. Two 14x16-in. timbers are used for each post, the back one carrying the cap. Chute bottoms are at 40 or 37 deg.

Ore withdrawn from the main chutes on the 2,700 level is reduced to 5 in. in one of two jaw crushers installed on the 2,800 level. These discharge into two raises with observation points on the 3,100 level and control chutes on the 3,250 level, below which they join the main raise leading to the chute on the 4,100 level. Here, additional primary crushing equipment is being installed. In the 4,100 level tunnel, broken ore is handled in 17-ton hopper bottom cars (doors operated manually). Haulage on the 2,700 level is done in 20-ton A-frame units with air brakes. The doors on each side of this car are operated by an air cylinder, the air being supplied through a short hose which is inserted into an automatic self-closing catch at the dumping station. A 12-car train can be dumped in from 3 to 10 minutes, depending on the condition of the ore handled. The 35-, 20-, 18-, and 15-ton locomotives operating in the main haulage levels are of General Electric, Westinghouse and Jeffrey manufacture. Track gage is 36 in., and 100-lb. rails are used.

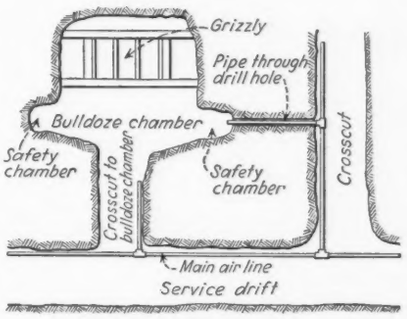


Fig. 3 . . . BULLDOZER CHAMBERS of this general plan are used for the large-scale retreating shrinkage system

In the Victoria tunnel tramming is done in 13-ton gondola-type cars, the track gage being 36 in. and the rails 45-lb. steel. Six-ton G.E. locomotives operating on 24-in. gage tracks of 45-lb. rails and drawing from six to nine 100-cu.ft. cars are used for auxiliary tramming. On the main haulage level 550-volt direct current is employed; the auxiliary trolley systems employ 250-volt direct current.

The precipitation plant at the portal of the 2,200 level tunnel contains 37 cedar tanks, each with two 5x5x5-ft. compartments. Cannery scrap, tin cans, and de-tinned cans are used as a precipitant, except in one tank that is built to accommodate old rails, pipe, and small pieces of scrap iron. The material used as a precipitant rests on wooden grating above inclined floors, and agitation is effected by low-pressure air introduced through perforated lead pipes inserted below the gratings. Water handled at the plant is that percolating through the old glory-hole workings of the Fairview orebody. Its flow varies between 6,000 and 40,000 gal. per hour, and the copper content per liter ranges from 0.6 to 2.0 grams. About 95 per cent of the copper is precipitated in 55 minutes of exposure. The sludge containing 67 per cent is dried, sacked, and shipped to the Tacoma smelter. Annual production amounts to about 1,200,000 lb. copper.

The mine power house, situated at 2,100 ft. elevation, contains compressor equipment capable of producing 14,500 cu.ft. per minute, some units being driven by Pelton wheels and others by electric motors; two motor-generator sets; a modern switchboard; and auxiliary machinery. The main switchboard and switch gear are housed in a steel-frame building at the portal of the 2,200 level tunnel. Power is received at 6,600 volts, with secondary distribution stepped down to 440 volts.

Ventilation at the mine is both natural and mechanical. Two Jeffrey Aero-Vane fans that handle 75,000 cu.ft. of air a minute are used together with several smaller units. Except in long development headings, fan pipe is not used. In the 4,100 level tunnel 22-in. fan pipe is utilized. Drifts and raise rounds generally are blasted at the end of the shift.

Freight and passengers are transported from the docks by an electric railroad to the foot of a single-track incline about 6,000 ft. long and rising 1,400 ft. to the 2,700 level. The flat cars operating on the track are actuated by an Allis-Chalmers hoist powered by a 150-hp. motor. The trip from the top of the incline to the different camps and mine surface plants is made over a surface rail system more than 3½ miles long, employing 15-ton G.E. locomotives and cars which can be taken into the mine at the 2,200 level portal either to the Victoria mine or to No. 1 shaft.

The Concentrator

At present the concentrator is handling in excess of 6,000 tons of ore a day, assaying less than 1 per cent copper. The chief copper mineral is chalcopyrite, although chalcocite and bornite are present in minute quantities. The remainder is pyrite, along with some gold and silver.

Though the accompanying flowsheet explains graphically the method of treatment at Britannia Beach, some additional facts will round out the story. One interesting feature is the removal of primary slime by washing and subsequent flotation in a separate machine, which has the following objects: (1) Removal of sticky mud from the ore simplifies the mechanical problem of getting tonnage through the crushing equipment, and (2) the elimination of a large part of the slime from the flotation machines in the main circuit materially increases over-all performance. Another feature is the floating of a bulk concentrate of pyrite and copper, and the subsequent separation of the two sulphides after dewatering,

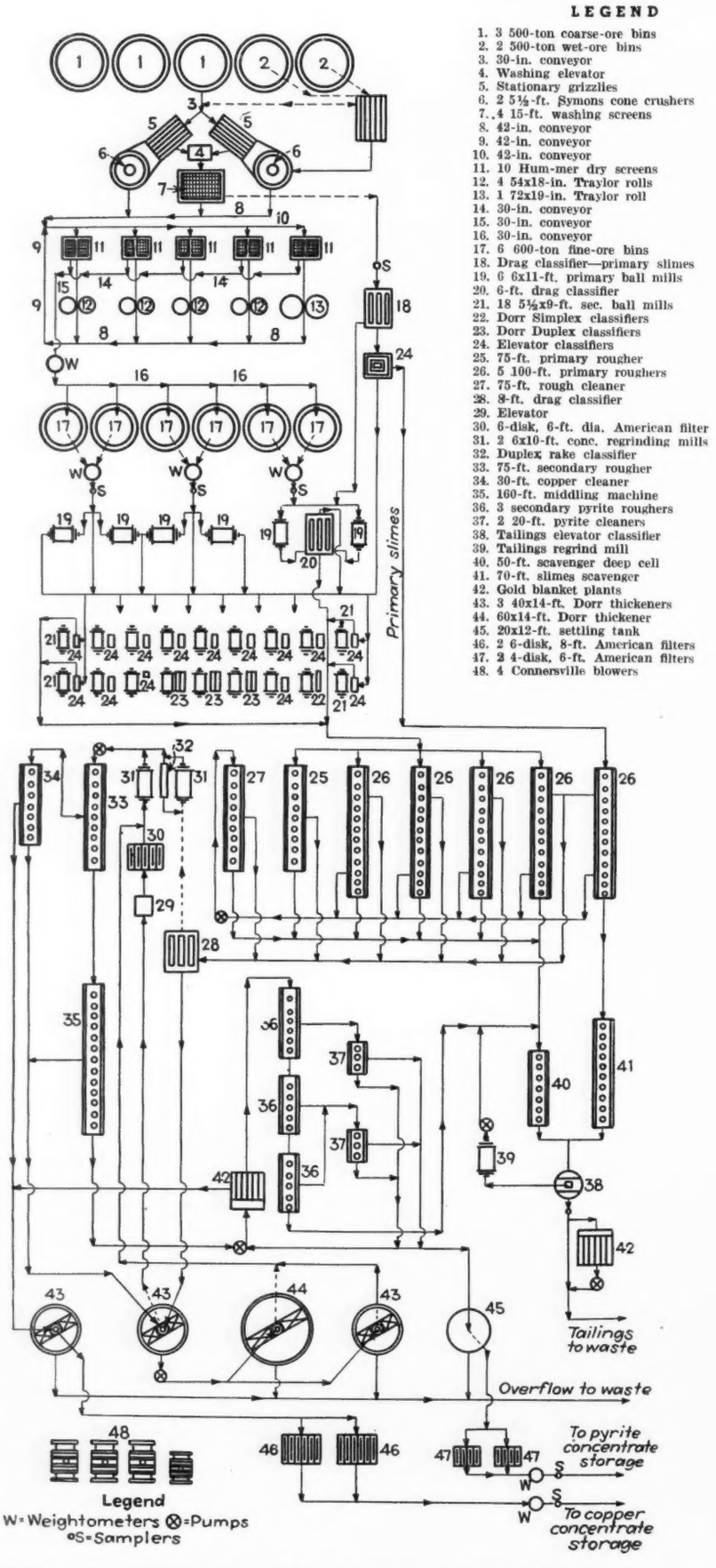

LEGEND
1. 3 500-ton coarse-ore bins
2. 2 500-ton wet-ore bins
3. 30-in. conveyor
4. Washing elevator
5. Stationary grizzlies
6. 2 5½-ft. Symons cone crushers
7. 4 15-ft. washing screens
8. 42-in. conveyor
9. 42-in. conveyor
10. 42-in. conveyor
11. 10 Hum-mer dry screens
12. 4 54x18-in. Traylor rolls
13. 1 72x19-in. Traylor roll
14. 30-in. conveyor
15. 30-in. conveyor
16. 30-in. conveyor
17. 6 600-ton fine-ore bins
18. Drag classifier—primary slimes
19. 6 6x11-ft. primary ball mills
20. 6-ft. drag classifier
21. 18 5½x9-ft. sec. ball mills
22. Dorr Simplex classifiers
23. Dorr Duplex classifiers
24. Elevator classifiers
25. 75-ft. primary rougher
26. 5 100-ft. primary roughers
27. 75-ft. rough cleaner
28. 8-ft. drag classifier
29. Elevator
30. 6-disk, 6-ft. dia. American filter
31. 2 6x10-ft. conc. regrinding mills
32. Duplex rake classifier
33. 75-ft. secondary rougher
34. 30-ft. copper cleaner
35. 160-ft. middling machine
36. 3 secondary pyrite roughers
37. 2 20-ft. pyrite cleaners
38. Tailings elevator classifier
39. Tailings regrind mill
40. 50-ft. scavenger deep cell
41. 70-ft. slimes scavenger
42. Gold blanket plants
43. 3 40x14-ft. Dorr thickeners
44. 60x14-ft. Dorr thickener
45. 20x12-ft. settling tank
46. 2 6-disk, 8-ft. American filters
47. 2 4-disk, 6-ft. American filters
48. 4 Connersville blowers
Primary slimes
Tailings to waste
Overflow to waste
To pyrite concentrate storage
To copper concentrate storage
Legend
W=Weightometers ⊗=Pumps
S=Samplers

Fig. 4 . . . FLOWSHEET at Britannia Beach incorporates a method for removal of sticky mud from ore to facilitate greater tonnage through crushers. Separation of copper and pyrite is made by bulk concentrate flotation

thickening, and regrinding of the coarse particles.

The concentrator stands close to the portal of the 4,100 level tunnel, and receives ore crushed underground to 5 in., the first step in the process being to dump material in the 17-ton cars into five 500-ton circular steel bins, of which two are set aside for use with wet ore.

All bins are equipped with sliding gates operated by compressed air. Ore drawn through the gates is belt-conveyed to three stationary grizzlies, spaced $\frac{5}{8}$ in., from which the oversize is directed to two 5½-ft. Symons cone crushers set $\frac{5}{8}$ in., and the undersize goes via a washing elevator to a screen composed of six 4x5-ft. sections. Undersize from this screen passes to the fine-grinding department, and the oversize goes to four sets of 54x18-in. and one set of 72x19-in. Traylor rolls, which operate in parallel and in closed circuit with ten Hum-mer dry screens having $\frac{3}{16}$-in. openings. The rolls are set shell to shell. The shells, cast at the company foundry, are allowed to wear down to 1 in. before being discarded. Consumption is about 0.19 lb. per ton of ore crushed.

Undersize from the Hum-mer screens is transported by a 30-in. belt conveyor to six circular fine-ore bins of 600 tons' capacity each at the head of the primary grinding floor. Here are six 6x11-ft. Allis-Chalmers mills, each driven by a 100-hp. motor, of which four operate in open circuit and two in closed circuit with a drag classifier. Two classifiers in series separate the sand from the slimes in the undersize from the crushing plant washing screens. Ball-mill discharge and classifier overflow go to elevator and Dorr classifiers operating in closed circuit with eighteen 5½x9-ft. Traylor secondary ball mills driven by 75-hp. motors. Each mill contains about 7½ tons of 3½-in. steel balls made locally from scrap rails, and the mill lining is made up of 7-in. lengths of hardened steel rails set on end in high-strength concrete. The elevator classifiers mentioned are the invention of A. C. Munro, superintendent of mills, with the patent rights being held by The Dorr Company. Briefly, they resemble a short, wide bucket elevator without a take-up pulley.

Secondary classifier pulp (3 per cent on 35 mesh, 25 per cent on 65 mesh, and about 42 per cent on minus 200 mesh) overflows at 26 to 27 per cent solids, and enters the primary rougher flotation machines. These as well as the cleaner units are of the Forrester type, manufactured by the company under a license granted by the Southwestern Engineering Company, of Los Angeles. The 50-ft. machine used in the tailing re-treatment circuit is a deep air cell type developed at the mill. Sizes of the flotation equipment

are given in the accompanying flowsheet. Air at 2-lb. pressure is furnished by four Connersville blowers. Consumption is about 45 cu.ft. per minute per linear foot of machine.

As pointed out in the foregoing, the general method of treatment in the flotation department is to make a bulk concentrate which contains the chalcopyrite, pyrite, gold, and silver. The coarse sulphides are removed from this concentrate in a drag classifier, the overflow from which is successively dewatered in three thickeners and a 6-disk American filter. The classifier sands are reground in a 6x11-ft. Allis-Chalmers ball mill in closed circuit with a duplex rake classifier, and the filter cake and the underflows from the thickeners are treated in a similar mill, the discharge from which, together with the rake classified overflow, goes to the secondary rougher, middling machine, and final cleaner cells in the copper section. Tailings from the cleaner machine are jointly thickened with the overflow from the dewatering classifier in a primary thickener, and those from the middling unit, after passing through a gold blanket plant, go to the pyrite flotation section. Final concentrates assaying 25 per cent copper and material from the gold blankets are treated in a second thickener, the underflow being further dewatered in two 6-disk American filters. All overflows excepting the overflow from the primary thickener go to waste. All thickeners are of Dorr make.

The three pyrite roughers are operated in series. Tailings from the last machine go to the deep air cell unit treating tailings from the rougher units in the bulk flotation section, and concentrates are re-treated in two 20-ft. cleaners. Final pyrite concentrates are treated both in a thickener and two 4-disk American filters before being conveyed to a stockpile near the dock. Cleaner tailings are returned to the head of the first pyrite rougher. In the final tailings-treatment plant, the deep air scavenger cell operates in closed circuit with a regrind unit consisting of a ball mill and an elevator classifier, with the classifier overflow going via a gold blanket plant to waste, and the mill discharge being returned to the flotation unit. Concentrates are pumped back to the head of the rough cleaner in the bulk flotation department.

Reagents are added at different points in the mill flowsheet as follows: About 0.5 lb. lime at the primary ball mills to give an alkalinity of 8.5 to 9 pH value in the rougher pulp; 0.10 lb. potassium ethyl xanthate and 0.07 lb. pine oil at the head of the bulk roughers; and 0.03 lb. pine oil at the center of each bulk rougher. Feed to the regrind mills receives 0.15 lb. lime and 0.02 lb. cyanide, and about 0.01 lb. butyl xanthate is added at the heads of the copper cleaners and middling machine. Small quantities of pine oil, just enough for frothing, are also used in this circuit. The pyrite is reactivated with ethyl xanthate, including very small amounts of pine oil, the xanthate consumption being 0.03 lb. per ton of ore treated.

Total recovery is from 88 to 89 per cent, and the ratio of concentration about 30 to 1. Tailings average 0.09 per cent copper. The pyrite concentrates contain 50.5 per cent sulphur, 44 per cent iron, and 0.4 per cent copper. Ball and liner consumption is 2.8 and 0.4 lb. respectively, and total power requirement per ton of ore treated is 16 kw.-hr. Over-all milling cost is about 30c. per ton.

Filtered copper and pyrite concentrates are transported by belt conveyors to covered storage bins of 6,000 and 4,000 tons' capacity, from which clamshell buckets operated from overhead cranes load them onto a conveyor discharging directly into the hold of the steamer. Sampling is done automatically wherever possible, and quick determinations made at a small laboratory at the concentrator help to stabilize milling operations every two hours. About an hour is required to make all determinations on tailings and rougher concentrates. The laboratory has been found most convenient also during experimental work.

Situated between the concentrator and the docks are the different repair shops, the general office, dormitories, a mess hall, a foundry equipped both with an electric furnace and a cupola, a department store, model houses for workers, a laboratory, and a ball-manufacturing plant containing the special machine described on a previous occasion in *Engineering and Mining Journal*.

The company has adopted a broad attitude in the treatment of its workers and in the development of the communities in which they live. Labor turnover is exceptionally low. A safety program under the direction of capable safety men has reduced accidents at the mine and mill. Change rooms and accommodations for the workers are being improved constantly, and a variable wage system based on the price of copper is being maintained. All stores are operated as purely cooperative ventures on the part of the company, with rebates being paid every six months. Group insurance and limited medical assistance are free. Besides a library and reading rooms there is available a large club house, in which dances and other social activities are held. The well-equipped gymnasium offers facilities for various kinds of sports and swimming.

The operating staff has taken advantage of improvements in mechanical equipment and technology, which were greatly responsible for enabling the company to continue operations through the present depression and solve many difficult problems. Plant officials include the following technical men: C. V. Brennan, assistant general manager; A. C. Munro, superintendent of mills; C. G. Dobson, mine superintendent; and Paul Everest, assistant mine superintendent. Thanks are due to C. P. Browning, general manager, for his permission to publish this article.

THE CONCENTRATOR AT SEA LEVEL

Interpretation Of Sludge and Core Assays

Sampling method and calculations employed sought accuracy in results from diamond drilling on a low-grade gold deposit in Nevada

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IN THE PROPERTY of the Nevada Porphyry Gold Mining Company at Round Mountain, Nevada, which has been under option to the A. O. Smith Corporation, the latter company undertook the difficult job of thoroughly sampling a very low-grade gold deposit of dispersed or areal type within a comparatively short period of time. In carrying out this work, most of the existing workings of the mine were thoroughly sampled and other drifts and crosscuts were driven for sampling purposes. Trenches were dug and sampled on the surface and several churn-drill holes were drilled. All of this sampling indicated a limited tonnage of possible ore, but the management was of the opinion that, in places, intervals between underground openings accessible to sampling were too large, and decided to use the diamond drill in an attempt to check and gain closer control within time limits set by an option agreement.

5-Ft. Samples Taken

The problem for the diamond drill was to get the most accurate sample possible from a comparatively low-grade ore in which the gold was more or less disseminated through a rhyolite porphyry. This problem presented difficulties in the recovery of good samples from the drill holes and in the correct interpretation of the assays of the samples obtained. The first few holes were entirely experimental, and it was found to be impossible to maintain water circulation and obtain good sludge recovery without casing the holes. From the nature of the ore at Round Mountain, a good sludge recovery was essential, and the practice was adopted of taking 5-ft. samples and carrying the casing up close to the bit whenever the sludge returns began to decline in volume. In this way a good recovery of combined sludge and core was obtained. Though the combined sludge-ore recovery was good, the core recovery and the sludge recovery were each variable, and, since the sludge assays were generally higher than the core assays, it was essential to determine what assay value should be assigned to the 5-ft. sample interval from the assays of core and sludge for that interval. A variation of $0.25 per ton was considered important. A decision as to how to combine the sludge and core assays was reached, based on the following discussion:

In sampling with the diamond drill, it is logically assumed that if all the material is recovered from a given sample interval, the assay value of this material is the assay value of the sample interval. If, in a given 5-ft. sample interval, a 5-ft. one-piece solid core is obtained, the assay value of this core would represent the assay value of the sample interval, and the sludge, if recovered in full and with nothing included except material from within the diameter of the hole, would in general check the core. In practice, however, it is seldom that the core is recovered in full and in one piece and that the sludge is recovered in full. At times, also, material in fractures and openings beyond the normal diameter of the hole is believed to be flushed out and recovered with the sludge. Suppose, though, in a given 5-ft. interval, that 4 ft. of core is obtained and that this core is broken into several pieces. This would indicate that in the given 5-ft. interval there is a total interval of 1 ft. in which there are probably several fractures in which the material is too soft to core. It is important to know the probable assay value of this 1-ft. interval, and the sludge assay for the 5-ft. interval does not give it directly. It can, however, be calculated with reasonable accuracy. If 4 ft. of core has been recovered from the 5-ft. interval, it is reasonable to assume that the assay value of this 4 ft. of core is the assay value of 4 ft. of the total 5-ft. sample interval. Therefore, the sludge from this 4 ft. should have the same assay value as the core, and, as the assay value for the total sludge recovered is known, it is easy to determine the probable assay value of the 1-ft. interval for which no core was obtained. To make this determination, it is necessary to weigh and assay both core and sludge separately, and one must know the theoretical weights for cores and sludges for a given sample interval when 100 per cent recovery is made. At Round Mountain, it was determined that for a 5-ft. interval, if 100 per cent recovery of both core and sludge is made, the core would weigh 2.85 lb. and the sludge would weigh 5.35 lb.

Sludge and Core Ratios

The ratio of sludge to core is not fully realized, perhaps, in a good many cases of diamond-drill sampling. The tendency may be to underestimate the importance of sludge assays, whereas, in the smaller sizes of diamond-drill holes, the sludge assays may be more important than the core assays because the sludge represents a larger volume of material from the sample interval.

The accompanying line-cut sections on page 37 illustrate the sludge-core ratios for the three smaller sizes of standard diamond-drill holes. The ratios will vary slightly, depending upon the gage set on the diamond bit.

In the accompanying table are presented a few actual samples taken at Round Mountain, with the data from which the assay value of the sample interval is calculated. These examples were selected to illustrate the extremes in the range of possibilities, and are not to be considered as representative of average values ob-

Table of Selected Core and Sludge Samples

Sample No.	Pounds Sludge	Sludge Assay	Pounds Core	Core Assay
12–D– 4	1.4	$21.20	2.2	$7.60
12–D– 6	5.4	1.40	2.6	0.55
12–D–20	4.2	5.22	2.3	1.35
12–D–29	5.7	4.12	0.6	0.35
12–D–41	3.6	1.40	1.4	5.02

tained in the sampling work at Round Mountain. The calculations are carried out and discussed as follows:

12-D-4: The core recovered was 2.2 lb., or 3.86 ft. Therefore if all material had been recovered for the 5-ft. interval, there should have been 5.35 plus 2.85 minus 2.20, or 6.00 lb. of sludge recovered. The sludge actually recovered was only 1.4 lb., so the sludge recovery was only 23.33 per cent. Now, for the 3.86 ft. of core recovered, there should have been recovered 4.13 lb. of sludge if the recovery had been 100 per cent. As the sludge recovery was only 23.33 per cent, the sludge recovered for this 3.86 ft. of core was only 23.33 per cent of 4.13 lb., or 0.96 lb. This leaves 0.44 lb. of sludge taken from the sample interval for which no core was obtained. That is, 0.44 lb. of sludge represents 1.14 ft. of the 5-ft. sample interval.

We have then: 0.96 lb. sludge at $7.60; 0.44 lb. sludge at "x"; and 1.40 lb. sludge at $21.20. From these figures, "x" is calculated to be $50.86, which is the calculated assay value for 1.14 ft. of the given 5-ft. sample interval. Then, since Sample No. 12-D-4 is composed of 3.86 ft. having an assay value of $7.60, and a total of 1.14 ft. having a calculated assay value of $50.86, the calculated assay value for the 5-ft. sample interval is $17.46.

Sample 12-D-6: Core recovered 2.6 lb., or 4.58 ft. Sludge recovery should have been 5.35 plus 2.85 minus 2.60, or 5.60 lb. Actual sludge recovery was 5.0 lb., or 89.3 per cent. Sludge recovery for 4.58 ft. of core was 89.3 per cent of 5.35 divided by 5 and multiplied by 4.58, or 4.38 lb. Sludge recovery for 0.42 ft. for interval in which no core was obtained was 5.00 minus 4.38, or 0.62 lb. Then: 4.38 lb. sludge at $0.55; 0.62 lb. sludge at "x"; and 5.00 lb. sludge at $1.40, from which "x" equals $7.40 and is the calculated assay value for 0.42 ft. of the given 5-ft. sample interval. Then, as the 5-ft. sample interval is composed of 4.58 ft. at $0.55, and 0.42 ft. at $7.40, the assay value for the entire interval is calculated to be $1.13.

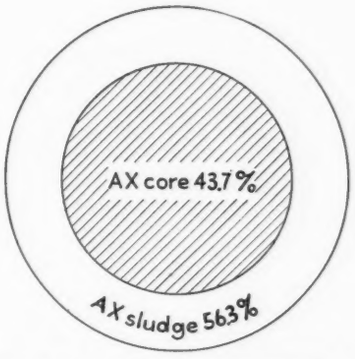
Calculating as in the foregoing, values for the other samples listed above are obtained as follows:

Sample 12-D-20: 4.04 ft. at $1.35 and 0.96 ft. at $15.73, or $4.11 for the 5-ft. sample interval.

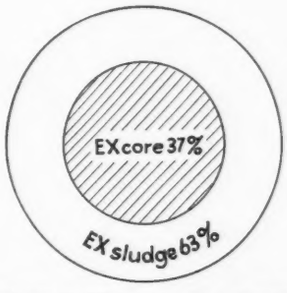
Sample 12-D-29: 1.05 ft. at $0.35 and 3.95 ft. at $4.80, or $3.87 for the sample interval.

Sample 12-D-41: 2.47 ft. at $5.02 and 2.53 ft. at minus $0.90, or $2.02 for the sample interval.

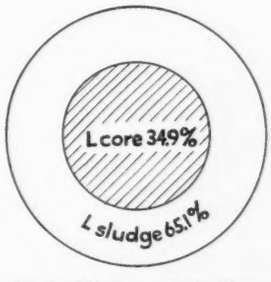
It will be seen that the assay values as calculated in the foregoing vary a small amount from the results that would be obtained if a weighted average of core and sludge is used. For example, in Sample No. 12-D-29, 5.7 lb. of sludge at $4.12 and 0.6 lb. core at $0.35 would give a weighted average for the interval of $3.63, which is $0.24 lower than the calculated average. In cases of close agreement between sludge and core assays, there is of course practically no difference between a calculated value and a weighted average, but where the sludge and core assays do not check, and the core and sludge recoveries are incomplete, the difference between a calculated value and a weighted average may become important. Factors determining this difference would be the variable assays of core and sludge, the variable percentages of core and sludge recovered, and the diameter of the hole drilled. Also, it will be noted that a weighted average gives no indication of the probable assay value of that part of the sample interval for which no core is obtained, whereas the calculation of these assay values serves to call to attention possible high-grade streaks within the sample interval which might otherwise go unnoticed.



Size AX bit is 1 13/16 in. outside diameter and core diameter is 1⅛ in. and ratio of core to sludge is indicated on sketches



Size EX bit is 1½ in. outside diameter and size of core is ⅞ in. diameter



Type L. bit is 1⅜ in. outside diameter and thickness of core is 13/16 in.

In calculating assay values for a sample interval as in the foregoing, several facts may present themselves for analysis before a final result is reached. It may be that the combined sludge-core recovery is in excess of 100 per cent. If such is the case, the excess sludge probably is due to sluffing in the hole. For purposes of calculation, all such excess sludge can be considered as coming from that part of the sample interval for which no core was obtained. The reason for this assumption is that if a part of the sample interval is competent to core, it would also be hard enough to prevent sluffing, so that any sluffing must come from that part of the interval for which no core was obtained.

Another interesting case is presented when both core and sludge recoveries are incomplete and the core assay shows considerably higher assay value than the sludge. This is the case in sample No. 12-D-41, presented in a preceding paragraph. In making the calculations for this sample interval, a negative value of $0.90 is obtained for the 2.53-ft. part of the sample interval for which no core was obtained. An actual negative value is of course impossible, but, for this particular sample, the value for the 5-ft. interval should be calculated as though this 2.53 ft. actually had a negative value. The probable explanation in this case is that the 2.47 ft. of core contained an accidental piece of high grade material which brought its assay value up too high, and the use of the negative value for the other 2.53 ft. of sample interval will compensate to some extent for such accidental high grade.

In carrying out the work at Round Mountain, a few simple graphs were used to facilitate the calculations. From them necessary figures can be read directly and calculations for the sample interval can be completed with a slide rule. The time required for the calculation of each sample interval is approximately three minutes.

Some Dust-count Data Derived With Wet Drilling and Ventilation

Subway contractors in New York City investigate methods of dust control that permit efficient practice in drilling operations

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▶ LEGISLATION *enacted in 1936 by New York State is seeking to combat silicosis by practical means, and to date equipment has been approved for use in dry drilling (E.&M.J. April, 1938). Approval of equipment for wet drilling in New York State is expected, however, to be announced soon. Meanwhile, numerous tests and experiments have been made by New York subway and tunnel contractors, using wet drilling and ventilation. The exhaust or suction type of dust control in dry drilling underground was also employed, and the results of both methods, as presented in this article, are of interest to the mine operator.*

THE PROBLEM of the control of industrial dusts has been brought to the front by episodes that have occurred in various locations. It has been said that if we remove dust and fumes we will eliminate practically all industrial diseases. Public attention has been directed recently to the dust hazard by the unfortunate incident resulting from the Hawk's Nest tunnel project during 1935 and 1936. The result has been that much unreliable information has been spread about and sensational political capital created. Unfortunately, the attitude of the engineer has not always been blameless.

The publicity thus created has had several reactions. On the one hand it has resulted in the enactment of much desirable dust-control legislation. On the other it has lent impetus to the adoption of stringent control measures and pernicious regulation based either on maliciousness or a total ignorance of the problem. The public has been led to believe that any one connected with the rock-drilling industries has received his death warrant and that industry was proceeding blissfully oblivious and heartlessly unconcerned with this major hazard. The fallacy of this view is sufficiently obvious to those familiar with rock drilling not to require refutation.

The problem of rock-drill dust control, in spite of its manifold aspects, is by no means an insurmountable one from a practical standpoint. Recently a group of New York contractors, required to comply with standards of dust hygiene, intelligently faced and solved the problem within economical limits of operation.[1]

The Silicosis Act of the New York State Legislature, effective June 6, 1936, vested authority for the administration of the act and the approval of devices and methods of silica dust elimination in the State Commissioner of Labor and Industry.

Following a series of conferences and reports by special committees representing the interested participants, a pubic hearing was held on Jan. 29, 1937, at which time the recommendations of the advisory committee were reported. These covered the permissible limits of dust concentration under varying conditions and defined the means of eliminating the dust, pending the approval of specific apparatus and methods. The rules apply to all rock drilling in silica-bearing rock and divide the rock into two classifications as follows:

1. "Any rock formation of substantially uniform geological character having free silicon dioxide as a component part which is known from geological studies or otherwise can be shown by the applicant (rock drilling employer) to the satisfaction of the Industrial Commissioner, to run uniformly less than ten (10) per cent by weight of the rock formation."

2. "All rock formation having free silica-dioxide as a component part, ten (10) per cent or more by weight, and all other formations, natural and synthetic, having a variable and unpredictable content of free silicon dioxide."

The rules then go on to define "injurious" silica dust concentrations as dust produced from drilling silica-bearing rock which is in excess of the following values as determined by approved dust count methods:

1. "One hundred million (100,000,000) particles per cubic foot of air (for rock in classification No. 1 above).

2. "Ten million (10,000,000) particles per cubic foot of air (for classification No. 2 above)."

Methods of operation shall permit no dissemination of injurious silica dust concentration into the atmosphere, and dust control may be effected with the exhaust or suction method, wet drilling or any other method that might be developed, provided the method is approved by the Board. The rules also provide for standards and procedure to which apparatus and methods shall be submitted for approval.

These regulations were approved by the Industrial Commission and became effective May 1, 1937. Soon thereafter several manufacturers of exhaust-system equipment submitted their apparatus for tests, and approval was granted for various sized units of the Kadco, Spencer Turbine, and Markley exhaust systems. (*E. & M. J.*, April, 1938, p. 56)

In the meantime the Compressed Air Institute had also submitted a list of 94 drills for the approval of wet drilling with ventilation as a control measure. However, due to the lack of adequate testing facilities by the State, approval was postponed for some time pending the acquisition of the necessary testing location. Eventually tests were performed at Tott's Gap, Pa., and a preliminary report was submitted on Sept. 9, 1937, fol-

[1] *Engineering News-Record:* "New Rock Drill Dust Control," Dec. 30, 1937. Page 1058.

lowed by additional information late in November.

Prior to the adoption of the code, as far back as 1936, several of the contractors in the New York metropolitan area had, on their own initiative, tested several of the dust traps then on the market under actual conditions of operation. They found that the experience of rock drillers throughout the world, and particularly in the Rand, in Ontario, Montana, and Arizona, to mention but a few of the localities where dust control has been vigorously pursued for many years, was not to be ignored. It demonstrated that the dust collector at its present state of development was impractical and unsuited to the usual underground working conditions, as apart from its performance under ideal tests or in certain foundation excavations or similar types of work where it does have a definite function. They concluded that under their operating conditions the efficient control of rock-drill dust was to be associated with the application of wet drilling and ventilation. The contractors therefore continued their former practice of wet drilling coupled with ventilation.

Contrary to general belief, the local exhaust dust collector is no innovation in the field. Various applications of this principal of dust-collecting hoods and local exhaust systems have appeared on the market during the last 35 years and numerous patents covering the design of such apparatus have been granted since Martin Hardsoeg was issued a patent in 1905. Yet few fundamental changes have evolved, and in spite of the attempt to comply with a fundamental axiom of industrial hygiene (that is, to remove the dust at its source) these dust traps have been unsuccessful in their application to underground work. Suffice it to say that nowhere, except in possibly isolated cases, have the collectors been adopted in the mining districts of the world.

Wet drilling and ventilation, on the other hand, have been the common practice for many years. In fact, the original method of simply directing water in a stream down the drill hole alongside of the steel long ago gave way to the present practice of admitting the water through a hollow drill steel.

In South Africa, where intensive dust control work has been conducted for over 30 years, wet drilling is universally recognized and required. Realizing that dust may be carried by entrapped air bubbles in the water, the codes are stringent in their requirements of the use of the so-called African dustless front head drills. These drills differ from our own American standards only in eliminating the possibility of compressed air passing down the drill steel with the water.

The experience in Butte, in Ontario, and Mexico has been along similar lines, and wet drilling, with the use of copious quantities of water, associated with adequate ventilation, is the standard practice today.

Following the approval of specific vacuum-exhaust equipment and pending the approval of wet drilling and ventilation standards, a special group of contractors of the General Contractors Association of New York, believing that their preliminary tests of

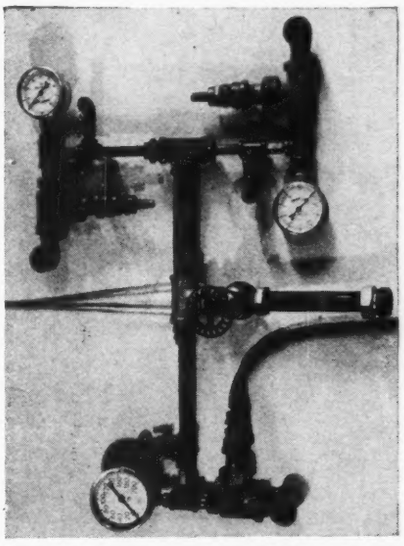

Fig. 1 . . . THREE-WAY EJECTOR used for taking three simultaneous impinger dust counts. Gage shows air pressure to each impinger that may be controlled with valves

the dust collectors warranted such measures, decided to initiate a vigorous investigation of the general problem of dust control. This group, headed by Fred W. Steifel, chief engineer of the Park Contracting Corporation and the Rosoff-Brader Construction Corporation, and A. Johnson, of the Arthur Johnson Corporation and Nacarro Company, Inc., directed the investigation. Tests in the field and dust sampling were conducted by the writers of this contribution. The Bureau of Mines, being vitally interested in the problem, was invited to cooperate, and a representative was in constant attendance as an observer. Benjamin J. Tillson consulting mining engineer, Montclair, N. J., was also associated with the work undertaken.

Dust counts were made with the Greenburg-Smith impinger in accordance with the standard method outlined in Public Health Bulletin No. 217. To enable taking simultaneously samples at the top, bottom, and rear of the drill carriage, three standard ejectors were coupled in series as shown in Fig. 1, thereby permitting a study of conditions in various parts of the heading under similar operating conditions. Additional tests were made with a Zeiss konimeter and a Bausch & Lomb dust counter.

The purpose of the investigation was twofold. First, wet drilling and ventilation methods would be tested under all the varying conditions to be met in the field and in accordance with the principles developed in the various mining regions of the world. These results, it was believed, would then enable definite standards of ventilation, drills, and water consumption to be formulated so as to comply with the standards of the New York State silicosis law. Second, it was the purpose of the investigators to conduct a series of tests of the local exhaust systems under field conditions to determine definitely their efficacy.

The geological conditions encountered are an important consideration in the design of an adequate dust-control method. Briefly, Manhattan Island consists of a series of overlying rock formations, with the Fordham gneiss, which is exposed in the northerly limits, overlain by the Inwood dolomite, which in turn is followed by the well-known Manhattan schist. It is the latter formation with which the contractors were primarily concerned. This formation is featured by numerous pegmatitic intrusions, consisting chiefly of microcline, quartz, biotite, and some feldspar in various degree of disintegration.

The rock has been declared by the Industrial Commissioner to contain over 10 per cent of free silica, which places it in the second classification, as applied to permissible dust concentrations. However, the mineralogical content is not the only consideration. Rather it is the character and structure of the rock that determines the method. Much of the rock is of various degrees of hardness, from an extremely soft disintegrated substance to a very hard, firm material.

In places the rock is very wet, whereas closely adjacent thereto it may be quite dry. Foliation is so close that the rock surface presents an undulating profile—so much so that in underpinning a building to sound rock, it is not uncommon to find it necessary to carry the piers on one end of a 25-ft. building as much as 10 ft. lower than at the other end. Obviously, then, with ever-changing conditions, the method of dust control employed must be flexible enough to accommodate itself readily to varying circumstances.

The first tests by the contractors were conducted on Section 10 of the Sixth Avenue subway, New York City, now under construction. This job offered a particularly attractive testing field, because the conditions available were so varied. Tests were made in an 18x18 ft. tunnel heading, a three-level drill carriage, carrying seven to eight 3-in. to 3½-in. wet drifters, being set up for drilling. Ventilation was provided by two blowers which could be operated indi-

vidually or jointly, for either blowing into the heading, or exhausting therefrom, 2,000 to 4,000 cu. ft. of air per minute.

Tests were made in a 14 x 18 ft. drift being enlarged into a 32x18 ft. tunnel by ring-drilling the sides, using the same drills, carriage, and blowers as in the smaller tunnel. In both tunnels an 8-in. steel ventilator pipe was carried along the side of the tunnel and up into the drill carriage with a demountable elbow, thus providing direct ventilation to the immediate working area. The exhaust or intake to the blowers, depending on whether air was blown into or exhausted from the heading, was direct to the street above.

Numerous additional tests were made in 11 x 11 ft. pits for elevated railway underpinning at depths of 5 ft. to 40 ft. below the street surface, using wet hand-held sinkers. Further tests were made drilling on a bench, under the timber decking, using wet hand-held drills. The natural ventilation under the last-named conditions was considerably enhanced because of the draft created by the numerous hatches and openings in the decking.

On Section 9 of the same subway a more intensive series of tests was made. This job offered not only an unusual method of excavation but clearly illustrated the fact that variable conditions met in the field required and permitted adjustments in the control measures which were entirely feasible because of the extreme flexibility of the wet-drilling and ventilation method, adjustments which permitted greater economy of control under certain conditions.

Following the removal of a shallow lift below the street surface to permit the erection of timber decking, the rock below was being excavated by drilling horizontally from a drill carriage and blasted after the manner of a tunnel heading. Three headings were carried forward between net lines simultaneously, in both a north and south direction. Drilling was accomplished by using a two-level drill carriage mounting six wet drifters, two at the upper level and four at the lower.

For ventilation, four 10-in. steel ventilator pipes were carried along the four corners of the jumbo and into the working face. The four pipes were joined through a manifold at the rear of a single 20-in. detachable, non-collapsible canvas tubing, which in turn connected to a permanently mounted 20-in. steel ventube about 100 ft. back of the heading. The latter pipe was led to the exhaust fan.

Exhaust ventilation was provided by a 10,000 cu. ft. per minute centrifugal fan which was designed to precipitate dust dynamically, aided by the dispersion of a water spray, prior to discharging the exhausted air into the street level.

The 3-in. Worthington H 169 drifters were especially designed to permit only water and no air to pass down the drill steel. In addition, the water consumption was increased by using oversized water tubes to pass approximately 1.5 gal. per minute per drill. With this arrangement it was found possible to maintain a dust count consistently below four million particles per cubic foot. Later, when the excavation had reached a level of 35 ft. below the decking and a clear unobstructed airway extended for over a thousand feet, it was found possible to dispense entirely with the mechanical ventilation, since the natural draft, together with wet drilling, yielded dust counts of under four million.

On sections 8 and 11, tests were made not only on wet drilling under

Table I—Determining Dust Count and Ventilation Using Wet Drilling in Tunnels

"Bottom" and "Top" denote location on drill carriage at drills where samples were taken

"Ambulant" samples were taken 20 to 25 ft. back of drills. All counts given in millions of particles per cubic foot of air under 10 microns in size.

*** Drilling dry**

No.	Drills Type	Type Vent	Total Ventilation, Cu. Ft. per Min.	Sample Taken	Dust Count	Ambulant Air	Net Count	Unit Ventilation, Cu. Ft. per Min. per Drill
Park Contracting Corporation — Section 9								
6	H 169	Exhaust	5,000	Bottom	10.40			833
5	H 169	"	"	Top	17.24	14.21	3.03	833
				Bottom	15.93	11.26	4.67	"
1	H 180	"	"	Top	16.70		5.44	"
"	"	"	"	Top	6.08	13.20	−7.12	833
"	"	"	"	Bottom	10.58		3.38	"
5	H 169	"	"	Top	4.63		−2.57	1,000
5–	H 169	"	"	Bottom	9.60		2.40	833
1–	H 180	"	"	Top	12.97	7.20	5.77	"
		Rotoclone		Bottom	9.29	4.17	5.12	1,667
6	H 169	Exhaust	10,000	Top	4.23		0.06	"
"	"	"	"	Bottom	3.43	1.96	1.47	"
				Top	3.76		1.80	"
"	"	"	"	Bottom	6.48	2.91	3.57	"
				Top	4.89		1.98	"
"	"	"	"	Bottom	7.40	9.62	−2.22	"
				Top	5.67		−3.95	"
"	"	"	"	Bottom	6.77	3.63	3.14	"
				Top	5.05		1.42	"
4	H 169	"	"	Bottom	10.94	9.76	1.18	2,500
				Top	6.82		−2.94	"
6	H 169	"	"	Bottom	9.03	1.15	7.88	1,667
				Top	0.95		−0.20	"
"	"	"	"	Bottom	9.15	5.09	4.06	"
				Top	12.43		7.34	"
"	"	"	"	Bottom	11.08	9.77	1.31	"
				Top	10.36		0.59	"
"	"	"	"	Bottom	4.35	4.50	−0.15	"
				Top	3.35		−1.15	"
4	H 169	"	"	Bottom	7.28	1.28	6.00	2,500
6	H 169	"	4,630	Bottom	4.04	3.12	0.92	771
"	"	"	"	"	4.19		1.07	"
				Bottom	2.38		0.30	"
"	"	"	"	"	2.45	2.08	0.37	"
				"	5.17		3.09	"
"	"	"	4,555	Bottom	2.33	2.50	−0.17	759
			"	Bottom	1.91	6.40	−4.49	"
				"	2.23		−4.17	"
5	H 169	Natural	"	Bottom	3.53			
1	CP 3½"			"	4.84			
Rosoff-Brader Construction Corporation — Section 10								
4–	H 180							
2–	H 169	Blowing	2,000	Middle	13.30	3.40	9.90	250
2–	D 89B							
"		Exhaust	4,000	"	12.00	5.30	6.70	500
"		Blowing	"	"	12.80		7.50	"
"		Exhaust	2,000	"	2.48	3.37	−0.89	286
"		"	"	"	17.04		13.67	"
"		"	4,000	"	11.85	12.67	−0.82	"
4	H 180							
1	H 169	"	"	"	14.93			571
2	D 89B							
4	H 180							
3	D 89B	"	2,069	"	12.42	11.11	1.31	295
					11.92		0.81	"
Spencer White & Prentice, Inc.,—Section 6								
6	DA 35	Rotofilter Exhaust	4,740	Middle	22.33	6.28	16.05	790
				Top	9.34		3.06	"
"	"	"	"	Top	23.88	5.01	18.87	"
			5,285	Middle	14.76	5.11	9.65	881
"	"	"		Top	12.38		7.27	"
4	Da 35	"	"	Middle	6.65	5.11	1.54	1,321
				Top	5.08		−0.03	"
6	H 169	"	4,577	Middle	11.22	4.02	7.20	763
				Top	6.33		2.31	"
4	H 169	"	4,863	Middle	6.45	2.36	4.09	1,216
				"	4.52		2.16	"
Walsh Construction Company								
8	DA 35	Natural		Bottom	8.97	4.21	4.76	
				Top	10.28		6.07	
3	DA 35	"		Bottom	14.31	4.89	9.42	
10	DA 35	"		"	11.34			
10	"	"		"	11.96			
10	"	"		Top	14.50			
10	"	"		"	15.21			
8	*DA 35	Spencer Turbine						
4	* "	Dust Collectors		Bottom	21.73			
4	* "	local exhaust		Top	7.96			
		"		Bottom	10.42			

Table II—Wet Drilling with Jack Hammers in Open Cut—Natural Ventilation

* Drilling dry

No.	Drills Type	Ventilation	Type Excavation	Sample Taken	Dust Count	Remarks
			Walsh Construction Company			
5	JA 55	Natural	Open shaft	Among drills	5.87	
"	"	"	"	12 ft. from drills	3.06	
			George H. Flinn Corporation — Section 11			
2	JA 55	Natural	Open cut	Among drills	6.49	
"	"	"	"	"	6.23	
"	"	"	"	"	15.12	Blast at 75 ft. during test
*5	JA 55	Kadco Dust Collectors with dry head drills	" L " pit Open shaft	Among drills	13.70	
None		Natural	Open cut		2.58	Taken prior to drilling
5	JA 55	"	" L " pit 28 ft. below street	Among drills	8.15	
"	"	"	"	"	8.23	
			A. A. Johnson & Necaro Company, Inc.— Section 7			
2	JA 55	Natural	Open cut decked	At drills	7.096	
4	JA 55	"	"	"	7.160	
None		"	During lunch hour	100 ft. back of bench	2.307	
2	JA 55	"	Open cut decked	At drills	5.00	
"	"	"	"	"	2.08	Taken 10 min. after blast
			Carlton Company, Inc.— Section 8			
1	JA 55	Kadco with dry drills	Open cut decked	At drills	13.39	
			Rosoff-Brader Construction Corp.— Section 10			
4	Worth J. H.	Natural	" L " pit 35 ft. below street	At drills	6.51	
1	Worth J. H.	"	Open cut decked	"	5.91	
			Spencer White & Prentice, Inc.— Section 6			
3	JA 55	"	Open shaft	"	2.04	
2	JA 55	"	"	"	2.10	
			Park Contracting Corporation — Section 9			
2	Worth J. H.	"	Open cut decked	"	3.10	
"	"	"	"	"	3.25	

various types of operation, but also on the approved types of vacuum-exhaust collectors. These tests proved the impracticability of the collectors so far as the local conditions were concerned. Although under certain ideal conditions it was possible to obtain satisfactory dust counts using the collectors, they failed to meet rigorous requirements of this type of work. Typical of the disadvantages were the necessity for expert supervision, the frequent failure of the apparatus when wet rock was encountered, and the difficulty with steel sticking when drilling wet, soft rock.

In an official test using a dust collector, 14 of 41 holes drilled were lost by steel sticking so as to be irretrievable. The average drill speed in this test using five dry-head blower-type drills was about two in. per minute, compared to the usual 10 to 12 in. per minute per drill when drilling wet. During this test, also, two of the suction lines became plugged by damp cuttings and had to be blown out with compressed air directly into the atmosphere of the working area.

On sections 6 and 7, tests were made on wet hand-held drills under the decking and in open shaft construction. Also, on the former section a series of tests was made on a new type of tunnel ventilator unit which promises to open a new field in the ventilation of tunnels.

The two 18-ft. tunnels were being driven much in the same manner as on Section 10; namely, full face operation, drilling with six wet drifters mounted on a three-level drill jumbo. For the purpose of ventilation four 8-in. steel vent pipes were mounted at the four corners of the jumbo, extended into the working face and joined at the rear, through a manifold, to a single non-collapsible canvas section of tubing. This short section of tubing was connected to a centrifugal fan and filter unit mounted on a truck, coupled directly to the rear of the drill carriage. The filtered air was then discharged directly into the tunnel. After some preliminary tests and adjustments this self-contained unit yielded dust counts below the required ten million.

At the Queens Mid-Town tunnel, tests were made on hand-held drills used in sinking the two Manhattan construction shafts. It was found that although at times satisfactory dust counts could be obtained with the dust collectors, equally good or better counts could be obtained with the wet drills using natural ventilation. In addition, the wet drills did not present the mechanical problems inherent with exhaust systems, as will be discussed further.

On the same job, four $17\frac{1}{2} \times 35$ ft. semicircular headings were being driven, so tests were made both on wet drills and on dry drills using the local exhaust systems. Since the headings had advanced less than 100 ft., no auxiliary mechanical ventilation had yet been provided for the wet drilling. Drilling was accomplished by using eight to ten Ingersoll-Rand D.A.35 $3\frac{1}{2}$-in. drifters mounted four to five each on two adjacent twin jumbos. With wet drilling and natural ventilation the dust count could be maintained at about the required minimum.

Later, when tests were made in these tunnels, using the same set-up of drilling but with dry blower type drills and exhaust hoods, the attempt proved a failure. Difficulty was encountered in adjusting the hoods against the blocky faces, and not only did this result in great loss in time but it permitted the dust to escape from the sides of the hoods and disseminate through the headings. The result was an abnormally high dust count; eleven hours were required to drill down a heading that normally had been drilled in five to six hours, and, finally, the drill runners, in several cases, particularly when drilling rim holes, refused to use the hoods, since it required so much jockeying of equipment to adjust the drill and auxiliary hood and connecting arm. When this occurred, using no hood and drilling dry, the worst aspect of

Fig. 2 . . . VENTILATION was supplied by a Rotoclone centrifuge fan having a capacity of 10,000 cu. ft. of air per minute. A 1-in. water connection at the inlet of the fan feeds about 5 gal. of water per minute into the centrifuge and mixes with the incoming air and traps the dust.

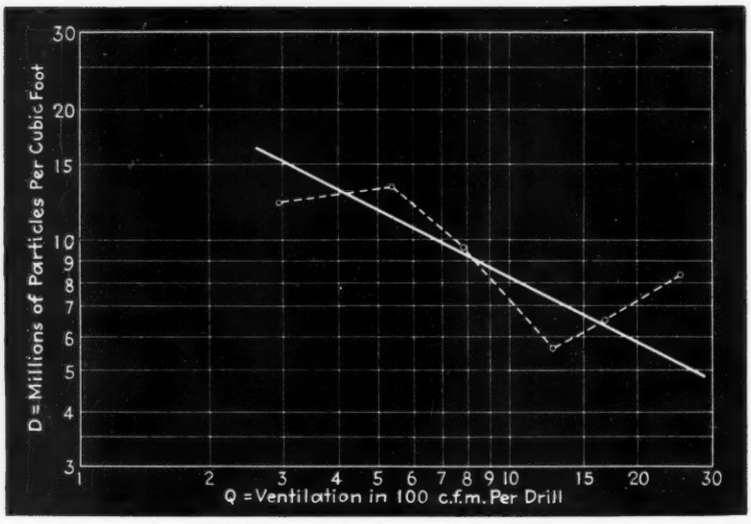

Fig. 3 . . . MATHEMATICAL REPRESENTATION of the relation of ventilation to dust count as determined by results of the authors' tests is presented in the above graph

the vacuum exhaust system was apparent—namely, it provides a dangerous potential hazard, in that failure to use the hoods at all times results in the unmitigated evils of dry drilling.

From the numerous tests made, and from observations in the field, it became increasingly evident to the contractors that under their operating conditions the only satisfactory means of control lay in the intelligent application of wet drilling and ventilation. It was also obvious that no hard-and-fast rules for quantity of ventilation and water consumption could be promulgated, for the reason that circumstances required variation. Recognizing, however, the necessity for certain standards, a proposed code was submitted to the Industrial Commission based on the test results accumulated.

Following a series of official tests of wet drilling on subway Section 9, a public hearing was held by Commissioner Elmer S. Andrews on Dec. 7, 1937, at which time tentative standards for wet drilling were submitted. These standards were based on results obtained at the experimental tunnel, Tott's Gap, Pa., by the Industrial Commission and differed somewhat from the results obtained by the contractor, particularly in the amount of ventilation required. An advisory committee was therefore appointed to study the proposed standards and adopt modifications in the light of the joint data available. The advisory committee has since formulated new standards for wet drilling and ventilation, which have been approved and adopted by the State Department of Labor.

In conclusion it may not be amiss to consider some of the objections to the vacuum-exhaust method as observed under field conditions. This is not offered to condemn the practice in general, for undoubtedly there are conditions under which it may be used successfully. Nor is it implied that the essential principle is at fault, for possibly some day an apparatus may be designed which will eliminate these faults, which summarized are:

1. In damp or wet rock the apparatus is practically worthless, since the damp cuttings tend to plug up the suction hose; the water frequently forms a trap in the hose, disrupting the suction; and much delay and many lost holes occur because of the steel sticking in the holes.

Fig. 4 . . . VENTILATION PIPE lying on each side of the top deck of the jumbo sucks in air and dust near the face. Absence of fog in this wet drilling operation permitted a clear photograph

2. Unusual supervision is required to keep the equipment in proper operation, and in the use of drifters in tunneling, exceptional skill is required to use the hoods with their adjustments properly.

3. A cushion of dust is frequently left at the bottom of the hole, requiring the blowing out of dry dust into the atmosphere before blasting.

4. It was observed that when blowing a hole, or when collaring a new hole, dust generally escaped from the sides of the hood. Collaring a new hole in blocky rock with the hood on is quite a problem, and in line drilling or drilling rim holes with drifters, the adjustment of hoods is such an arduous task that they are frequently not applied by the drill runners.

5. The flexible hoses used for suction are frequently bent and distorted by being stepped on or injured by heavy tools and equipment, particularly in the close quarters usually prevailing in tunnels.

6. Except in special cases, the use of vacuum hoods generally slows up the progress of the work.

7. Finally, since the equipment is susceptible to such frequent mechanical and physical defects, any disruption in its operation results in malignant dust dissemination which is only inherent to dry drilling. This great potential hazard is of extreme importance, since no amount of lecturing or wishful thinking will stop a drill foreman from continuing to drill just because a dust collector has become defective or discarded. In contrast, the relative simplicity and effectiveness of the wet drilling method primarily bars this malpractice.

Tables I and II give a summary of 125 tests made under varying conditions. The results obtained and the scope of the investigation clearly establish the efficiency of the wet drilling method.

An attempt was made to average the various tests in groups so as to arrive at some sort of mathematical representation of the relation of ventilation to dust count. Though it is recognized that it is impossible to arrive at a definite mathematical relationship applicable to all cases, since each case presents its own variable conditions, the curve is instructive and offers some basis for a criterion. The graph shows that there is a definite decrease in dust concentration with an increase in ventilation; that when the unit ventilation in tunnels is maintained at 800 to 1,000 cu. ft. per minute per drill, a dust count of ten million particles per cubic foot can be readily obtained; and that any considerable increase in ventilation above this figure does not appreciably affect the count.

The equation $D = \sqrt[26]{Q}$, where D = dust count in millions of particles

per cubic foot and Q is the ventilation in 100 cu. ft. per minute per drill, is certainly not all-inclusive, and possibly it is based on an insufficient number of tests, but it may serve as a fairly good criterion.

The standards for the testing of wet-drilling equipment and the "Wet Method" of dust control as approved by the Industrial Commission in February, 1938, are as follows:

Standards for the Testing of "Wet" Drilling Equipment and "Wet Methods" of Dust Control

Section I. Definitions:

A. "Wet Method" of dust control: Refers to such sanitary measures as lockers, baths, toilets, etc.

B. Wet Drilling:

1. Wet drilling shall mean the continuous application of water through the central hole in the hollow drill steel to the bottom of the drill hole. The central hole in the steel shall not be less than $\frac{1}{8}$ in. diameter.

2. The water flow shall be maintained continuously whenever the drill is in operation, including the period of collaring or starting the drill hole. The valve in the water line shall be of such design that it has only two fixed positions; namely, closed and completely open. Six months after date of approval, all wet drills shall be equipped with a combination air throttle and water valve of such design that the required rate of water flow through the drill steel will be insured whenever the air throttle is in the operating positions, half speed as well as full speed.

3. The water shall be clean and bacteria-free and shall be delivered to the drills under pressure from an adequate source of supply. Portable water tanks for individual drills shall not be used unless approved by the Industrial Commissioner.

C. Open and confined areas:

1. Open area shall mean any location directly open to the general atmosphere except at the bottom of pits and shafts at a depth of more than three times the smallest cross-sectional dimension of said pit or shaft.

2. Confined area shall mean any location underground or beneath decking or in pits and shafts at a depth of more than three times the smallest cross-sectional dimension of said pit or shaft.

Section II.

A. *Class I Rock, Open or Confined Areas*

Wet drilling in Class I rock in open or confined areas *without the use of mechanical ventilation* shall be approved, subject to the following provisions:

1. Hand-held drills (maximum piston bore 3 in.) minimum rate of water flow through drill steel 0.75 gal. per minute.

2. Drifter-mounted and wagon-mounted drills (maximum piston bore 4 in.) minimum rate of water flow through drill steel, 1.5 gal. per minute.

B. *Class II Rock, Open Areas*

Wet drilling in Class II rock in open areas *without the use of mechanical ventilation* shall be approved, subject to the following provisions:

1. Hand-held drills (maximum piston bore 3 in.) minimum rate of water flow through drill steel, 0.75 gal. per minute.

2. Drifter-mounted and wagon-mounted drills (maximum piston bore 4 in.) minimum rate of water flow through the drill steel, 1.5 gal. per minute; no direct blowing of air through the drill steel shall be permitted during collaring and backing the drill-steel out of the drill hole.

C. *Class II Rock, Confined Areas*

Wet drilling in Class II rock in confined areas shall be used with *mechanical ventilation,* or in confined areas under decking by natural ventilation, if approved by the Industrial Commissioner and subject to the following provisions:

1. The rock surfaces for a distance of 30 ft. from the heading or other drilling area shall be maintained in a damp condition.

2. Hand-held drills (maximum piston bore, 3 in.) minimum rate of water flow through drill steel, 0.75 gal. per minute; maximum rate of air flow through drill steel at full speed, 2.0 cu.ft. per minute; maximum rate of air flow through the drill steel at half-speed operation, 1.0 cu.ft. per minute; minimum rate of general ventilation in the drilling area, 500 cu.ft. per minute per drill and shall be increased if found upon tests by the Industrial Commissioner that the dust concentration is not in accordance with the requirements of the code.

3. Drifter-mounted and wagon-mounted drills (maximum piston bore, 4 in.) minimum rate of general ventilation per drill in the drilling area, as shown in Table III.

4. In the case of positive-pressure ventilation, the air must be well distributed over the drilling and must not create drafts at the various drilling positions, in a manner satisfactory to the Industrial Commissioner. The intake for the ventilating system must be located at a point free from contamination with dust or provided with an efficient filter.

5. In the case of exhaust ventilation, the location of the intake pipe or pipes must be such as to insure the removal of air from the entire drilling area in a manner satisfactory to the Industrial Commissioner.

6. The required ventilation may be obtained by means of a recirculating air-cleaning apparatus provided the dust concentration in the air at the breathing zone of the drill operators is maintained at a level below that required in Rule 33-2.3 and the apparatus is otherwise acceptable to the Industrial Commissioner.

7. The above rates of ventilation shall be increased whenever necessary to reduce dust concentration to the amount permitted by Rule 33-2.3.

Table III—Standards for General Ventilation in Confined Areas, Using Drifter-mounted and Wagon-mounted Drills (Maximum Piston Bore 4 In.)

Class of Drill	Limitations in Air and Water Flow Through Steel: Air Flow	Water Flow	Full-speed Operation Air, c.f.m.	Full-speed Operation Water, g.p.m.	Half-speed Operation Air	Half-speed Operation Water, g.p.m.	Ventilation (a)
I	High	Low	4–6	0.5–0.75	5–12	0.5–0.75	2500
II	Medium	Medium	2–4	0.75–1.5	2–5	0.75–1.5	2000
III	Low	High	0–2	1.5 & over	0–2	1.5 & over	1200

(a) Minimum rate of ventilation for one drill—cubic feet per minute.

Fig. 5 . . . SAMPLING AIR at the face by the impinger method to determine dust count—Drilling is in Manhattan schist

Section III.

Application for Approval of Wet Drills

The manufacturer of wet drills shall determine the rate of air and water flow through the drill steel under the observation of a representative of the Industrial Commissioner at the maximum operating air pressure and minimum water pressure for which the drill is designed. The data thus obtained shall form the basis for action by the Board of Standards and Appeals.

Sphalerite—A Study

PART II

Some sedimentation-flotation tests — The conclusions

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IN THIS PART of the study three types of tests were undertaken as follows: Set 1, to determine the effect of xanthate on sphalerite sedimentation curves; Set 2, to determine the relationship between flotation of sphalerite, using a frother only (no xanthate), and sedimentation rate; and Set 3, to determine relationship between sedimentation rate (degree of dispersion) and flotation recovery, using xanthate.

Set 1—Effect of Xanthate on Sphalerite Sedimentation Curves

Using a constant xanthate concentration (10 mg. sodium amyl xanthate per liter), the experiments which gave the results presented in Fig. 3 were repeated. Since the sedimentation curves for this condition were as nearly like those of Fig. 3, Part I, as any new set of data without xanthate could be expected to be, the curves are not here presented. The conclusion is that xanthate has little or no effect on the stability of sphalerite suspensions.

Set 2—The Relationship Between Sphalerite Flotation (Without Xanthate) and Its Sedimentation Rate

Although it is stated[1], and it is the general understanding among flotation men, that unactivated sphalerite practically does not float, our experience is that pine oil and various others of the well-known frothers, including caprylic acid, heptylic acid emulsol (X-1), and terpineol (0.25 lb. per ton) give recoveries up to 82.6 per cent.

Four species of sphalerite, having chemical analyses as shown in Table III, were tested. Pure frothers alone in distilled water gave recoveries as recorded in Table IV.

In the recovery tests to follow, Tri-State jig concentrates, ground dry in an Abbé pebble mill and wet-screened through 200 mesh, were used. Numerous efforts were made to learn why there was sphalerite flotation with only pine oil and without activator. We have no explanation for this flotation. G. H. Buchanan and L. J. Christmann ("The Effect of Certain Chemicals on the Floatability of Galena, Sphalerite," American Cyanamid Company, Technical Paper No. 9, p. 6) record sphalerite recovery data for pine oil, cresylic acid, and o-toluidine. There is recovery in each case, recovery varying with type and concentration of reagent. Gaudin ("Milling Methods," A.I.M.E. p. 236, 1934) attributes recovery of fine sphalerite (400 to 2,000 mesh) to mechanical collection ". . . between bubble walls, and part of it by adherence to gas bubbles . . ." The peculiarity of the Buchanan-Christmann recovery curves makes application of this theory of collection difficult. We do not know what the explanation is, and pass it. The relation of this type of flotation to sedimentation data is of interest, and data on this phase of the study are given in Figs. 4-b, 5-a, 5-b.

Sedimentation - Recovery Curves—There is apparent, in the case of these reagents shown in Figs. 4a[3] and 4b, a striking relationship between per cent recovery and per cent dispersion—maximum dispersion and minimum recovery obtaining at about the same solute concentration. Recovery increases and dispersion decreases with changing solute concentration on either side of an optimum concentration. The relationship is so impressive that explanation of flotation, when only pine oil is used, on a basis of purely mechanical collecting on films between bubbles, is wholly inadequate. At least a modification in the hypothesis is needed to include the factor of particle ionization; high ionization resists collection in such bubble films. Sodium hydroxide, possibly not quite in this class, but yet a salt of the weak acid, HOH, is included in the group and on the figure. Its flotation recovery and sedimentation curves conform to those of other members of this group.

Fig. 5a allows a discussion of the sedimentation-recovery curves of $CuSO_4$, $ZnSO_4$, $Cr(NO_3)_3$, $Ca(NO_3)_2$, $Pb(NO_3)_2$, and $Al(NO_3)_3$. Reagents of this group have such substantial effects on flotation, but, on the other hand, such negligible effects on sedimentation, that parallelism between the two phenomena is difficult and unsafe to make. Generally speaking, there does not seem to be any clear-cut and well-defined relationship.

All of these reagents in the low concentration range are sphalerite depressants, with the exception of $Pb(NO_3)_2$, which has a promoter effect. Its sedimentation curve also is lower than that of any other of the group, and is substantially and persistently below that of water. Copper sulphate has a marked promoter effect[2] in the higher concentration range.

Chromium nitrate has a substantial dispersing effect at a concentration of 5 to 10 millimols. At this concentration, per cent recovery, although less than in pure water, is greater than for lesser and/or greater solute concentrations. The outstanding data of this group of reagents are those for lead nitrate.

In discussing the sedimentation-recovery curves of Na_2SO_4, $NaC_2H_3O_2$, and $Na_2C_2O_4$, Fig. 5b is used. This group of reagents consists of very weak dispersants of sphalerite, and the reagents are at the same time flotation depressants. Further than this statement, nothing can be said.

Set 3—The Relationships Between Sedimentation Data and Flotation Recovery Using Xanthate

The experiments and data under this part of the study are of far more interest than those of Sets 1 and 2, as practical flotation results are not being had with only the use of frothers. Xanthate in the absence of an activator is not a collector of sphalerite. In these tests, 1.5 lb. of pentasol xanthate (Great Western Z-6) was used per ton of mineral.

Discussion of the sedimentation-recovery curves of Na_2CO_3, Na_2HPO_4, NaCN, Na_2HAsO_3, and NH_4OH is taken up in conection with Fig 6. Reagents of this group, as has already been pointed out, are, in varying degrees, strong dispersants of sphalerite. This dispersion (Part II, Set 1) is in no way affected by xanthate.

Sodium carbonate, in low concentrations, is a dispersant, falling off in dispersing power with increasing molar concentration. It is without marked effect on sphalerite recovery. Normal water recovery (without xanthate) practically is maintained throughout the solute concentration range. The

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* Laboratory contributions by H. Gordon Poole and Robert H. Raring, Research Fellows, 1931–32 and 1932–33, respectively, Idaho Bureau of Mines and Geology; also by Donald Ingvoldstad and E. Maurice Walters, Research Fellows, 1934–35 and 1936–37 respectively, U. S. Bureau of Mines.

[1] Gaudin, Flotation, p. 205.

[2] Buchanan and Christmann (ref. cited) made the same observation.

[3] See Part I, June issue, p. 53.

Table III—Chemical Analyses of Sphalerite Samples Tested

Sample	Pb	Zn	Fe	Cu	CaO	S	Insoluble
Tri-State concentrates	0.1	63.8	0.2	0.03	0 0	32.1	0 8
Tri-State	9 9	43.6	1.8	0.10	0 55	24.4	14 8
Ruby Creek	0 1	48.8	0.1	0.03	2.02	24.8	17 2
Pend Oreille	0.1	53.5	1.8	0.02	1.56	26.7	8.6

Table IV—Average Recoveries of Sphalerite Using Only Frothers and Distilled Water on Three Species of Sphalerite

Sample	Ave. Per Cent Dispersed	pH	Ave. Per Cent Recovered	pH
Tri-State	9.3	6 4	89.0	6.8
Ruby Creek	8 7	7 2	71 0	7.3
Pend Oreille	9.9	7.2	55 5	7.3

Table V—Flotation of Sphalerite in Solutions Containing a Constant Amount of KCN and Variable Amounts of NaOH

Test No.	KCN C.c. of 0.1 M. sol. in 500 c.c.	KCN mm./l	NaOH C.c. of 0.1 M. sol. in 500 c.c.	NaOH mm./l	pH	Recovery Per Cent
1[a]	0 0	0.0	0.0	0.0	6.5	97.3
2	5 0	1.0	0.0	0 0	8.0	8 1
3	5 0	1.0	1.0	0 2	8.7	14 5
4	5.0	1.0	5.0	1 0	9 6	4.8
5	5 0	1.0	495.0	99.0	12.6	0.0

[a] Distilled water plus xanthate only.

explanation conjectured is that sodium ion has no capacity to activate sphalerite. The carbonate or basic carbonate of zinc cannot form, as both are more soluble than zinc sulphide. As zinc sulphide is itself less soluble than zinc xanthate, the carbonate or basic carbonate could not possibly promote flotation. The state of the sphalerite suspension in this case appears to have no relation whatever to recovery. This is thought to be the case because here flotation (although xanthate is present) is not xanthate flotation; it is still frother flotation, whatever the mechanism involved may be. The strong negative charges on the particles, causing their dispersion, appear not to be a factor in this type of flotation.

Sodium dibasic phosphate, Na_2HPO_4, although a somewhat stronger dispersant than sodium carbonate, gives a recovery curve that may be said to be parallel to that of the carbonate. The explanation offered for its impotency is the same as for sodium carbonate—the non-activating highly insoluble zinc phosphate may or may not be involved here; it would seem not to be.

Potassium cyanide, like the carbonate and the phosphate, is a strong dispersant of sphalerite; its dispersion curve, however, falls off only slowly with increased solute concentration. Unlike the phosphate and the carbonate, it markedly depresses sphalerite flotation, per cent recovery passing through a minimum at a solute concentration roughly giving maximum dispersion. The same state of affairs exists in non-xanthate flotation, so depression here has no meaning in relation to xanthate flotation. Xanthate in low concentrations does not enter the picture in any way. In the higher concentration, cyanide tends to reactivate sphalerite. The explanation probably is that sphalerite increases in solubility, whereas zinc xanthate does not.

Sodium arsenite gives sedimentation and recovery curves generally similar to the respective potassium cyanide curves. The flotation depressing action, however, continues with increasing solute concentration into the high concentration range. These same two reagents, as well as NH_4OH, were flotation depressants in the Set 2 experiments in which only pine oil was used.

Before proceeding with a speculative discussion of the probable reaction, it should be pointed out that cyanide also depressed frother (non-xanthate) flotation. Off-hand, depression may be attributed (1) to surficial formation of insoluble $Zn(CN)_2$, (2) to the complex ion $Zn(CN)_4^{--}$.

In view of the data for sodium phosphate and sodium carbonate, depression in the case of cyanide cannot logically be attributed wholly to the dispersed state of the suspension; the anchored S^{--} or HS^- ions, which are

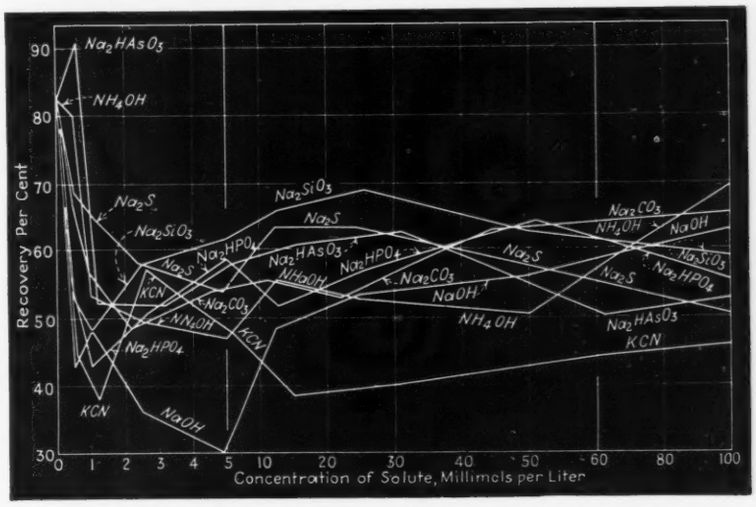

Fig. 4b . . . SEDIMENTATION CURVES for this group of reagents indicate a striking relationship between per cent recovery and per cent dispersion

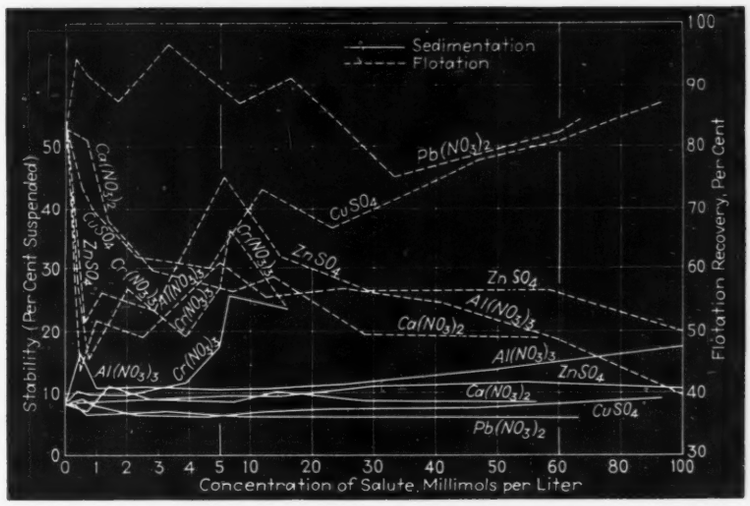

Fig. 5a . . . SEDIMENTATION RECOVERY CURVES of $CuSO_4$, $ZnSO_4$, $Cr(NO_3)_3$, $Ca(NO_3)_2$, $Pd(NO_3)_2$ and $Al(NO_3)_3$ exert their effect on flotation but have little influence on sedimentation. In general a well-defined relationship between the two does not seem to exist

thought to be responsible for dispersion, are therefore not the complete source of the depression action. Flotation depression must, it would seem, be due, in addition to particle ionization, to highly insoluble $Zn(CN)_2$. This hypothesis is somewhat weakened by the fact that phosphate, which salt of zinc also is highly insoluble, shows little depression. To attribute depression to the complex ion, $Zn(CN)_4^{--}$, is also open to objection, as there is sharp depression at solute concentrations less than one millimol per liter, which concentration presumably is too low to dissolve $Zn(CN)_2$ and, therefore, to form the complex. If flotation is attributed, say, in the case of xanthate, to formation on the mineral surface of insoluble xanthate of a metal[3], then, as copper xanthate is soluble in free cyanide, depression may be attributed to non-formation of the surficial xanthate compound. This explanation also is open to many objections. Wark and Cox ("Principles of Flotation," V, A.I.M.E., Tech. Pub. 732, p. 15) state: "It is generally accepted that the action of cyanide in preventing the flotation of sphalerite is to convert the copper in solution or already on the sphalerite surface to a soluble cupricyanide complex, thus reducing the copper ion concentration to less than that at which it can activate sphalerite." The fact that cyanide is a depressant of sphalerite, in the cases of both frother-flotation and xanthate-flotation, introduces a complication unsurmountable with the data in hand. One other factor entering which differentiates KCN from Na_2HPO_4 and Na_2CO_3 is the acidic strength (ionization constants) of the weak acids of these salts and the further fact that in NaCN only one sodium is involved. NaCN therefore gives much weaker basic reaction. What is needed in order to get at the answer to the problem here involved is additional solubility data of the xanthate and cyanide of zinc at various pH values.

Sphalerite flotation data in Table V bring out the importance of the pH factor in the control of the action of cyanide on sphalerite. In these five tests, the cyanide concentration was constant at 7.5 mg. (1.5 lb. per ton of sphalerite); 1.5 lb. per ton of pentasol xanthate was used as a collector.

Test No. 1 showed very good flotation; all of the mineral was removed in about two minutes; the pulp was flocculated. The pulp was strongly dispersed in Tests 2, 3, and 4, and the floatability was low in all cases, as shown by the table. Test 3 shows the best recovery, and it is possible that another concentration of NaOH might be found, which would give better than 14.5 per cent recovery. In Test 5, the pulp was quite well flocculated, but the mineral showed no tendency to float; practically no stable froth was formed, and the mineral floccules had no tendency to adhere to the air bubbles.

[3] Copper is present in this sample to the extent of 0.03 per cent; lead, 0.10 per cent; iron, 0.2 per cent.

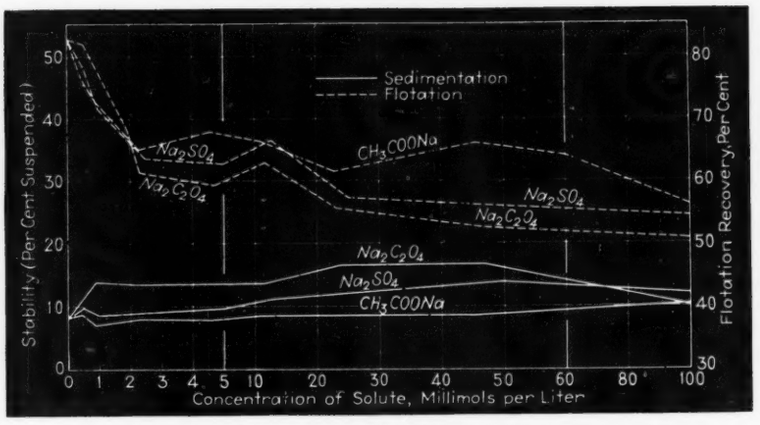

Fig. 5b . . . SEDIMENTATION RECOVERY CURVES of this group of reagents consist of weak dispersants of sphalerite as well as flotation depressants

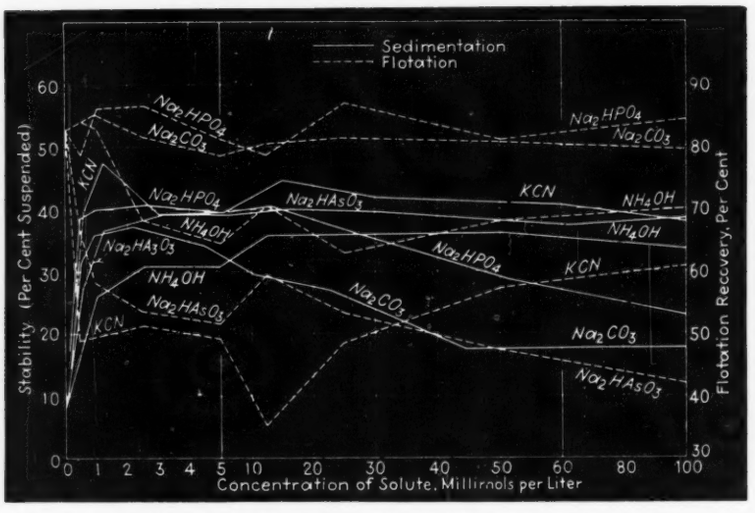

Fig. 6 . . . SEDIMENTATION RECOVERY CURVES of these reagents are in varying degrees strong dispersants of sphalerite. Sodium diabasic phosphate (Na_2HPO_4) gives a recovery curve almost parallel to sodium carbonate. The dispersion curve of potassium cyanide falls off slowly with increased solute concentration

The answer suggested for this case is that a highly insoluble zinc arsenite is formed, which, unlike in the case of cyanide, is insoluble, either in excess of the solute or in solution of increasing alkalinity. Addition of NaOH may or may not increase floatability, depending upon the solubility of arsenite of zinc in alkaline solutions.

Ammonium hydroxide, NH_4OH, also like cyanide and arsenite, is a dispersant and at the same time depressant of sphalerite. It is, however, less potent in both of these capacities than the two reagents just discussed.

Up to one millimol, it has little effect, the maximum effect obtaining at about 5 millimols, thereafter depression remaining about constant, decreasing slightly with concentration, as also does dispersion. Dispersion and flotation depression in this case are attributed to insoluble $Zn(OH)_2$.

Summary and Conclusions

1. The experiments of this paper deal (1) with the settling rate, and degree of ionization of sphalerite in aqueous media; (2) with the effect of minute concentrations of various solutes on sphalerite dispersion; (3) with the effect of xanthate on sphalerite dispersion in aqueous solutions of various electrolytes; and (4) with the relation of sphalerite dispersion to its

floatability with (a) frother reagents only and (b) xanthate and frother.

2. Sphalerite is not at all, or is only slightly, dispersed in distilled water.

3. Zinc sulphate has little effect on the state of a sphalerite-water suspension; pH is an important factor.

4. Copper sulphate, although undoubtedly copper atoms displace zinc atoms on the sphalerite surface, has only slight effect on the state of the suspension.

5. The weak acid salts of sodium all, in varying degree, are dispersants of sphalerite. Ionization and dispersion are attributed to HS^- or S^{--} anion, aided by the tendency of the cation, Zn^{++}, to form insoluble salts of the weak acid radicals.

6. Neutral sodium salts of the strong acids are without effect on sphalerite dispersion.

7. Frothers, such as pine oil, cresylic acid, caprylic acid, heptylic acid, emulsol (X-1), and terpineol (0.25 lb. per ton), in the absence of activator or xanthate, give sphalerite recoveries up to 86.6 per cent. An explanation for this type of flotation, referred to in the manuscript as "frother flotation," is not offered.

8. In frother flotation, there is a very noticeable, and, in the cases of several of the reagents treated, an outstanding, relationship between sphalerite dispersion and sphalerite recovery —strong dispersion and depressed floatability parallel each other. Flocculation, however, is not necessarily accompanied by enhanced floatability.

9. Lead nitrate is an outstanding activator of sphalerite frother flotation. It is at the same time a strong flocculator of sphalerite. Lead acetate, although not as potent as the nitrate, also functions as a sphalerite activator.

10. When xanthate is added, there is no satisfactory relation between the state of sphalerite suspension and flotation recovery. Sodium carbonate and sodium dibasic phosphate, in small concentrations, are dispersants but have no effect on recovery, whereas, for example, potassium cyanide and sodium arsenide are both strong dispersants of sphalerite and depressants of sphalerite recovery. (Those heavy metal salts, however, that have a flocculating action on sphalerite, invariably promote flotation recovery.) The addition of xanthate seems to have no effect on the stability of a sphalerite suspension regardless of what inorganic solute is present.

11. Cyanide is the most potent depressant of sphalerite of all the reagents tested. Sodium arsenite falls next in order. With cyanide concentration constant, variable pH has a potent bearing on sphalerite recovery. A satisfactory chemical explanation for the action of cyanide, as well as others of the reagents studied, is not available.

Operating Costs Of a Small Gold Mine

Authors believe that more small producers should publish their cost data

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AS THE AVERAGE investor in small mining ventures is frequently a man with little or no training in the industry, mining publications have made an effort during the past year to give such investors some method of determining what returns they may expect on properties of a certain size and with a certain grade of ore. The articles presented have dealt mainly with gold mining and have sought to impart technical information by the use of curves, charts, and other statistical data, usually assembled from reports of the United States Bureau of Mines.

It is interesting to note that none of these articles so far observed make any effort to differentiate between properties which are in the prospecting stage and those which have ore definitely blocked out. To compile any set of statistics which would apply to mines of the first type is obviously impossible, and the tables which have been compiled set the figures much too high to apply to the second.

The average mining man has to depend to a great extent on uninformed Eastern men for his capital, and it is the opinion of the authors that the misleading character of some articles published recently is working a real hardship on the man who seeks capital and doing the potential investor absolutely no good. The fact that the investor who puts money into development of the raw prospect takes a long chance, is recognized, but it is also recognized that his chances for success cannot be determined by any statistical calculations but must be arrived at as closely as possible by the competent engineer who spends much time and study on the property concerned. Such statistics, therefore, lose all value when the investor tries to make any individual application of them.

Based on figures reported by the United States Bureau of Mines one writer has stated that a mine with a 100-ton daily capacity would require ore with a value of 0.35 oz. per ton, or $12.25, to pay costs of amortization, mining, milling by flotation process, and other complementary costs. It is the purpose of the authors to show, by use of a concrete example, that this figure and corresponding figures which have been published recently are much too high. Production and cost figures from May 1, 1937, to March 1, 1938, on the Portland mine, in Mohave County, Ariz., operated under lease by the Gold Standard Mines Corporation, will be used. Although the mine was being operated prior to this period, most of the ore was mined by the open-pit method and the costs of mining were considerably lower, and, therefore, less representative of the average mine of this size. During the period mentioned, almost all of the mining has been underground, with daily production averaging 105.86 tons.

The reader should be made acquainted with a few facts so that he may realize that the cost of producing an ounce of gold at the Portland mine is at least average. The mine is 52 miles from Kingman, Ariz., the base of supplies, and is accessible only by dirt roads that are washed out several times each year by heavy rainfall. Water for mining, power, and camp purposes must be hauled a distance of 3 miles from a spring producing 1,800 gal. a day. Any additional water required is hauled 18 miles from the mill. All ore produced is transported over the same road, which must be worked constantly to assure efficient truck service.

Air-generating equipment consists of a 600-cu.ft. Sullivan compressor driven by a 100-hp. semi-diesel engine, and a 325-cu.ft. portable compressor actuated by a gasoline engine. Although the semi-diesel operates efficiently, the portable unit uses on an average some 40 gal. of gasoline per 8-hour shift. Because it is necessary to stock as much as 2,000 tons of ore at the mine, bins cannot be used and the ore must be stockpiled, and subsequently trans-

ferred to the trucks by means of a power shovel.

The Gold Standard mill, which is an all-slime continuous counter-current decantation cyanide plant and treats the Portland ore, is 35 miles from Kingman, 2 miles from the Colorado River, and 18 miles from the Portland mine. Water is pumped from the river, obtaining a head of 500 lb. per square inch. Power used at the mill is generated in Kingman and purchased at 2c. per kilowatt-hour. These adverse conditions are to a certain extent offset by the fact that the ore occurs in a vein ranging from 5 to 20 ft. in width, but averaging about 15 ft. This apparent advantage in turn is offset by the fact that the ore is very hard. The vein lies at an angle of 27 deg. from the horizontal, and the oreshoot has a maximum length of 200 ft. and tapers at depth to considerably less. The mine operates on a basis of two 8-hour shifts per day, and the staff includes a superintendent, a mine engineer, a shiftboss, a diesel engineer, and an assistant. All purchasing and bookkeeping are done at the mill.

The tabulated costs to follow may be broken up as indicated: Direct mining costs include supervisory and engineering overhead, power costs, water hauling, road maintenance, repairing and equipment, actual mining and mucking, and development. During the period under consideration, development work includes sinking of a 200-ft. inclined 8x16-ft. shaft in ore, sinking of a 6½x10-ft. vertical shaft in waste 92 ft. deep, 175 ft. of drifting in waste, and 350 ft. of diamond drilling. Direct milling costs include power, materials, labor, maintenance, insurance, and workmen's compensation, and indirect milling costs include general overhead, such as assaying, office overhead, staff salaries, and general camp costs. Total milling costs may be slightly below average for a mill of 100 tons' daily capacity, because during the period under consideration the Gold Standard mill handled ore from other properties in the district in addition to that from the Portland mine, or a total about 181.48 tons per day.

Operating Costs per Ton of Portland Mine

Direct mining	$1.8480	
Taxes	0 0437	
Insurance	0 0115	
Depreciation	0.0403	
Workmen's compensation	0 1043	
		$2 0478
Royalty	$1.010	
Hauling	1.150	
		2.1600
Direct milling	$1.635	
Indirect milling	1 008	
		2 6430
Extraction loss (based on 94.923 per cent extraction)	$0 374	0 3740
		$7.2248

Direct milling costs include $0.456 per ton for powder and $0.2722 per ton for depreciation.

From the foregoing tabulation it may easily be seen that the Portland mine requires an average value of 0.20642 oz. gold per ton, or $7.225, in order to produce gold at $35 per ounce. Reverting to the figures first cited, it becomes apparent that the mine would have shown a profit of $5.025 per ton if the ore had averaged as much as 0.35 oz. gold per ton. In other words, these costs are 41.1 per cent lower than the minimum to which reference was first made.

It is the sincere hope of the authors that the foregoing facts may help to correct an erroneous impression among laymen, as well as provoke a trend of thought among actual operators, leading to similar articles on small properties with different sets of conditions than the one described. Such articles should be much more informative to the potential investor than simple statistical data.

Reduction Ratio Curves for Crushing And Grinding

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THE REDUCTION RATIO obtained in a crushing or grinding machine is commonly understood to mean the ratio between the diameter of the largest piece in the feed and that of the largest piece in the product. According to this definition, if the feed to a crusher contains pieces ranging up to 4 in. in diameter, and the product ranges up to 1 in., the crusher is said to have a reduction ratio of 4 to 1.

However, the reduction ratio in crushing is sometimes based upon the crusher opening on the open side, rather than upon the diameter of the largest piece in the product. If the crusher referred to above is set at a ¾-in. opening, the reduction ratio is then said to be 4 divided by ¾, or 5⅓ to 1.

In either case it is merely an approximate method of designating the amount of work done in the machine, and is likely to be misleading, since the reduction ratio of the largest piece in the feed and product is frequently very different from that of the average sized piece. The reduction ratio of the average piece is obviously a better criterion of the amount of work done than that of the largest piece.

A method of evaluating the reduction ratios existing between the various size fractions of the feed and the corresponding product, including that of the average sized pieces, is highly desirable, as it would permit direct comparisons of the distribution of the work done by different machines, or by the same machines with different operating conditions and when treating different materials.

This article describes my development of such a method, and discusses some of the results obtained with it.

Complete screen analyses of the feed and product are made with screens in the Tyler Standard Screen Scale, and the per cent cumulative weights retained are plotted as ordinates against the screen sizes as abscissas. For convenience, the screens are assigned ordinal numbers, with 200 mesh as No. 41, 150 mesh as No. 42, 100 mesh as No. 43, and so on up the screen scale. A difference of one ordinal, or size, number is given a constant interval on the graph.

It should be realized that when this is done the per cent cumulative scale represents the material arranged in the order of particles of decreasing size. That is, zero per cent cumulative retained represents a point just beyond the largest piece in the sample, and if the entire sample is visualized as being arranged in a single line of particles of decreasing size, from the largest at one end to the smallest at

the other, the per cent cumulative plot represents correct intervals along this line.

The horizontal distance between the plotted curve of the feed and that of the product at any selected point along the graduated size lines represents the reduction ratio at that point. The numerical value of the reduction ratio is one-half the distance between the ordinal number of the feed and the corresponding product, as the interval between screens is the square root of 2.

Detail of Procedure

The distances between the feed and product curves are conveniently measured with dividers, and the resulting reduction ratio curve is plotted on the same sheet, as shown in Fig. 1. This curve gives the numerical value of the reduction ratio at any desired point of size distribution of the feed or product, and the corresponding mesh size is found from the ordinal number of the feed or the product at that point.

The median reduction ratio is the reduction ratio at 50 per cent cumulative weight retained, as that represents the midpoint of the graduated size line, and it is much more indicative of the actual work done on the material than is the initial reduction ratio at zero per cent retained, which is the reduction ratio based upon the largest pieces in the feed and product.

It is sometimes desirable to extend the reduction ratio curve below 200 mesh, or size No. 41. This can be done by extending the distribution lines.[1] The logarithm of the per cent weight retained is plotted against the screen ordinal numbers, and extended as a straight line below 200 mesh, using the same slope as that between 100 and 200 mesh. This gives the Log. per cent weight at any ordinal number between 41 and 28, and from this the per cent and per cent cumulative can be calculated, so that the plotted per cent cumulative of both the product and the feed can be extended below 200 mesh to any desired size. No. 28 is the beginning of the colloidal size range and the practical limit of reduction in grinding.

As the finer particle sizes are approached, the corresponding reduction ratios at those sizes ordinarily increase, so that a typical reduction ratio curve ascends steeply toward its maximum value as 100 per cent cumulative retained is approached. The reduction ratio is more constant at the coarser sizes, and the minimum point may vary from zero per cent cumulative to the median value at 50 per cent cumulative, or even higher.

The numerical value of the reduction ratio is also the ratio of the surface areas of the product and the feed at that point. Thus in curve (a)-(c) in Fig. 1 the median reduction ratio is 4.26 to 1, and the surface area of the median product is 4.26 times that of the median feed. As it is generally accepted that the new surface area produced in grinding is proportional to the net work done, it follows that the reduction ratio curve delineates the actual work distribution among the various screen sizes, for the particular feed, machine, and conditions considered.

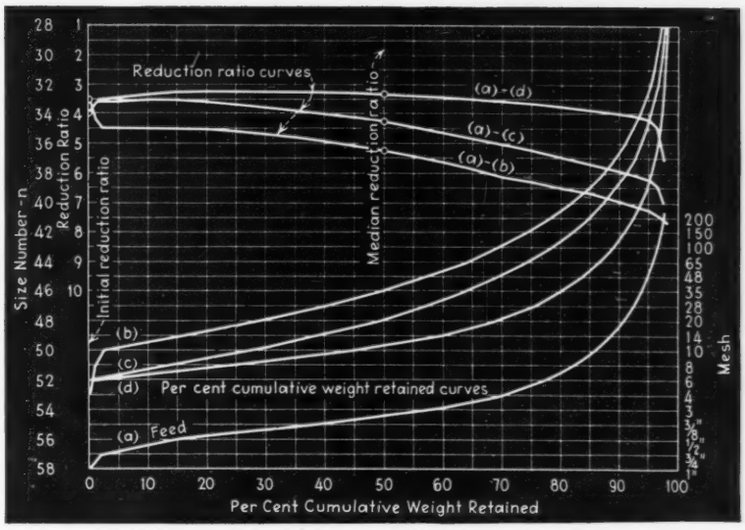

Fig. 1 . . . CRUSHING AND GRINDING TESTS and the subsequent screen products of a gold ore as it passes through the gyratory, open-circuit rod mill, and the closed-circuit rolls are plotted above. A number of tests tend to show that work done by jaw, gyratory, and roll crushers affords even distribution throughout the various screen sizes

Explanation of Fig. 1

Fig. 1 shows the results of a crushing and grinding test on a gold-bearing rock from Montana. Curve (a) represents the product of a small gyratory crusher set at $\frac{3}{8}$-in. opening on the close side. The gyratory product constituted the feed for open- and closed-circuit dry rod-mill tests, and a roll crushing test. The closed-circuit tests were made at 6 mesh. Line (b) represents the open-circuit rod-mill product, (c) the closed-circuit rod-mill product, and (d) the closed-circuit roll product with the rolls set at $\frac{1}{16}$-in. opening. The corresponding reduction ratio curves are designated as (a)-(b), (a)-(c), and (a)-(d). It is noted that in each case the reduction ratio increases as the finer particle sizes are approached, and that in both of the rod-mill tests the median reduction ratio is considerably larger than the initial value at zero per cent cumulative. The median reduction ratio of the closed-circuit roll product (c) is near the minimum value. In the rolls (d) a greater proportion of the total work input was done on the larger pieces than in the rod-mill tests, and the work distribution was about parallel in the open- and closed-circuit rod-mill grinds.

A number of tests have been made, and these tend to show that the reduction ratio curve is flatter, and consequently that the work done is more evenly distributed throughout the various screen sizes, when machines which have a fixed maximum opening, such as a jaw or gyratory crusher, or rolls, are used, rather than a rod or ball mill. The latter machines, and especially the ball mill, tend to concentrate the work done on the finer screen sizes.

Screen analyses can sometimes be anticipated with fair accuracy if the desired median reduction ratio is assumed and a curve drawn through it parallel to a reduction ratio curve obtained by crushing or grinding a similar material under similar operating conditions.

Curves Aid in Design of Machine

The accumulation of a series of reduction ratio curves covering various materials, and various crushing and grinding machines, conditions, and median reduction ratios, would greatly facilitate the study of mineral comminution.

When a certain size distribution of product is desired, the proper machine and conditions could be selected by referring to these data with more facility and certainty than is possible at present, and fewer individual tests would be required. Furthermore, such data should also be of material assistance in the design and construction of new machines.

[1] "Grindability and Grinding Characteristics." By Fred C. Bond and Walter L. Maxson. A.I.M.E. Tech. Pub. No. 888, March, 1938.

Where Jigs Replaced Sluice Boxes

The author records the operation of a dragline dredge and the methods employed in recovering gold and other concentrates found in an Idaho gravel deposit

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IN WRITING THIS ARTICLE I shall try to bring to the reader a picture of the construction, development, and operation of a modern-designed dragline gold dredge, together with some suggestions for prospective operators. Before doing this, it would be well for the reader to know something of the general conditions and features of the particular gravel deposit in which operations were conducted, and the characteristics which governed us in the original design of the dredge, its operation, and the changes that were made later.

The De Lamar placer is located on Jordan Creek, Idaho, and extends downstream from the famous De Lamar quartz mine and other old gold producers in the district. The country is mountainous, and the flats along Jordan Creek vary from a narrow strip of land to several hundred feet wide. Several dikes of fairly hard rock cross the stream bed, making some shallow depth of gravel. The entire deposit runs from 6 ft. to 18 ft. in depth. Boulders are large and quite numerous. The gravel contains no clay and washes readily, and 70 per cent of the bedrock is soft. The surface is covered with brush in places and some parts of the district contain scattered areas of trees.

Years ago, when the De Lamar quartz mine was operating, low gold recovery was common in many of the old mills, and Jordan Creek served as a large sluice box for tailing disposal. The stream rises and falls rapidly with heavy rainfalls, and it is not uncommon to have from one to three large freshets that cover the flats each season. Therefore, fine gold, floured quicksilver, amalgam, slimes, and tailings from mills have been deposited along its source for many miles below the mines mentioned.

The ground was tested by sinking steel caissons to bedrock. These caissons are from 48 to 64 in. in diameter and are telescoped. Excavated gravel was washed in a 6-mesh trommel screen and the free gold was recovered by riffles. The tailings were carefully sampled, and a fire assay was run for gold and silver to determine the values that were not recovered. A small selected but typical list of the results of testing is given herewith.

Table I—Value Per Cubic Yard of a Selected List of Tests

Number	Free Gold	Concentrates	Per Cent Fines Minus-6 Mesh
A	$0.09	$0.43	16
B	0.33	0.15	19
C	0.24	0.42	24
D	0.41	0.32	20
E	0.18	0.27	34
F	0.44	0.33	44
G	0.09	0.23	17
H	0.15	0.37	38
I	0.19	0.09	45
J	0.09	0.18	17
K	0.35	0.10	45
L	0.15	0.19	30

When testing, we did not determine the amount and value of free gold lost over the riffles. I estimate that 20 per cent of the value of the concentrates in the lower-grade holes was fine gold that did not deposit in the riffles. The results of testing checked fairly well with the operation. I question whether the ordinary riffles on an average dredging operation recover much more than 80 per cent of the values, and in most instances the recovery is below that. Naturally our free gold losses in testing showed up in the assays of the concentrates.

The term "doodlebug" was first applied to the early dragline dredges. The machine was the outgrowth of a dry-land gold-saving plant, either mounted on wheels or skids and advanced or pulled along as the power shovel or dragline moved forward with its digging.

Experience in the industry evolved into placing washing and gold-saving equipment on pontoons and considerable improvement in design has been made in late years.

The first boats were somewhat unstable as to keeping an even keel, and hence the new dredge was dubbed "doodlebug," and this name has generally followed the dragline dredges, but many consider the term a misnomer. Published reports indicate more than 42 such machines are operating in California, together with a growing number in other states. They vary from the "doodlebug" to types that are as up to date in gold-saving devices as any bucket-line dredges operating in the United States.

I will first describe the De Lamar placer operation employing riffles, and then describe the operation after all the riffles had been replaced with jigs.

De Lamar Placers (Brendel Interests, of Pittsburgh) started the construction of their dragline dredge late in 1936, and it was ready to operate in January, 1937. It was designed to handle capacity output of a 2-cu.yd. Northwest dragline. The hull is built of well-seasoned 3x12-in. Oregon fir. The edges of all lumber were beveled so as to aid in caulking. It was built bottom side up to facilitate caulking and was then turned right side up into the pond with the dragline hoist. The top was then laid and caulked, the corners of the hull were ironed with wearing plates, and all braces were bolted between the partitions. There are twelve partitions running crosswise of the boat and cross-braced every 4 ft. Twelve hatchways along the center line of the boat allow egress to every watertight compartment. There are also two suction pipes from the deck to the bottom of each compartment, one on each end, to which the suction from the bilge pump on deck can be attached and the hull dewatered. The upper framework and housing of the boat is made of heavy timbers with 2x6-in. studding. The sides are double-boarded, with roofing paper in between the boards to aid in keeping the boat warm during cold weather. About

50,000 ft. of lumber was used in the entire construction.

The steel framework for the equipment is of 7-in. I-beams that were cut and arc-welded together on the job. All lattice bracing is 4x4-in. angles. The boat was built equipped with riffles, but construction was so designed as to give headroom for other forms of gold-saving devices. The lower end of the trommel screen was 8 ft. above the deck, but we later found that another 8 in. or 9 in. in headroom would have been right for the equipment we later installed. The steel hopper, trommel screen, stacker, all sluices, and the electric winches were purchased from the Bodison Manufacturing Company, San Francisco, Calif.

In this dredge the hopper is 10x12 ft., but in building another of this capacity I would prefer to have it a little larger. The bottom consists of a double layer of steel plates separated by 2 in. of wood filling so as to cushion the fall of the gravel as it is dumped from the bucket. The slope of the bottom is 3¼ in. to the foot and the opening into the screen has been enlarged to 30 in. in diameter. However, the slope on the bottom of the hopper depends on the nature of the gravel.

Originally, a grizzly over the hopper discarded large boulders back into the pond, but the grizzly has been removed and boulders too large for the trommel screen are dumped back of the dragline. As these large boulders accumulate, a caterpillar equipped with a bulldozer pushes them to one side and off the gravel deposit. Large boulders that sometimes get into the hopper are skillfully removed by the dragline operator. It is possible, perhaps, for a grizzly to work satisfactorily on a different type of deposit, but as a rule extra equipment usually means more trouble.

The screen is of the heavy type, 54 in. in diameter by 28 ft. long. The screen plates are replaceable and are held by countersunk bolts. We varied the size openings in the screen from ⅜-in. holes with 1¼-in. bridging at the head of the screen down to the same size of holes with ¾-in. bridging, and the last two sets of screen plates, each 4 ft. in length, have ½-in. openings with standard bridging. The discharge end of the screen has a 6-in. drop to the stacker belt. It is well to make the drop as low as possible, as it lessens the fall of the tailings on the belt, prevents dragging on the conveyor belt, lengthens the life of the belt, and makes a lower lift for the stacker motor.

We are using 2x3x36-in. steel bars for baffle plates inside the screen. They are curved to fit the screen and are arc-welded in place and staggered to slow the flow of material through the screen and allow perfect washing. We found that higher baffle bars tended to retard large boulders too much and pounded the screen plates. The trommel is rotated by a chain-driven 30-hp. motor running 1,800 r.p.m. with a Pacific reduction gear to maintain proper speed.

The stacker has a 30-in. belt operated by a chain-driven 10-hp. motor running 1,800 r.p.m. with a reduction gear that maintains speed of the stacker belt around 280 ft. per minute. This motor is set at the head of the belt. The stacker is completely housed and has a catwalk on each side. We have had no trouble with this stacker and do not lack for power, even when loaded heavily with large rocks. A 2x8-in. fir guard rail sloping at an angle of about 45 deg. acts as a safety rail to keep large rocks from rolling off the belt.

Riffles are 1¼x24-in. steel angles sloped ¼ in. from the vertical, which is approximately standard for all steel angle riffles. These riffles were placed on all the tables and in the downstream sluices. From 4½ sq.ft. to 6 sq.ft. of riffles is required for one yard per hour, and the slope was 1¼ in. per foot. The distributor is of standard design and maintains a satisfactory feed to all the riffles.

The four winches, placed in the "doghouse" on top of the boat, were the first of this particular type of electric power winch to be made by the Bodison Manufacturing Company. They have a rope speed of 60 ft. per minute, and each drum winds 700 ft. of cable. The lines are run out opposite in manner to those on a bucket dredge. The stern lines are fastened on shore to the upstream side, whereas the bow lines cross the stern lines and fasten ashore on the downstream side. This allows the winches to hold the boat in place and the only pressure against the lines after the boat is in position is the velocity of the current in the pond and the wind pressure. The loading and dumping into the hopper and the operation of the equipment on the boat impose little strain on the lines.

Water required varies from 600 gal. to 1,500 gal. per cubic yard of gravel washed, whereas ladder dredges in California use about 3,300 gal. of

Fig. 1 . . . DeLAMAR PLACER on Jordan Creek, Idaho, is being exploited by this well-housed floating dredge, having a capacity of washing 3,000 cu.yd. of gravel per day. The bucket used on the dragline weighs 6,300 lb. The water tank that supplies water to the jigs can be seen on top of the "doghouse"

water per cubic yard of washed gravel. One double-suction 8-in. Bingham pump with a speed of 1,800 r.p.m. is used for washing in the trommel and a 3-in. pump is used for cleaning-up purposes. The large pump is direct-connected with a 50-hp. motor and the smaller pump is direct-connected with a 10-hp. motor.

Electric power is purchased from the Idaho Power Company and is transformed from 23,000 volts down to 2,300 volts at our transformer house and brought to the dredge through a rubber cable, where it is transformed down to 440, 220, and 120 volts. Current at 220 volts is used for arc-welding.

Heavy Bucket Used

The design of a bucket for digging gold placers is of importance. The standard 2-cu.yd. bucket for a dragline seldom weighs over 5,000 lb. Approximately 1,200 lb. of plate steel were added to the back, bottom and sides for additional weight to keep the bucket flat down and prevent riding on its teeth when digging bedrock or hard gravel. This extra weight did not unbalance the bucket. The cutting edge between the teeth, built up with Stoodite, should lie in a straight line, and, if anything, should curve slightly outward. Long, sharp teeth are essential for fast digging, and teeth are changed at the end of each 8-hour shift. At present H. & L. detachable nickel-chrome teeth are used. They wear sharp and when worn back too near the base are discarded and new tips attached. We believe this method helps maintain lower cost per cubic yard.

The dragline operator casts the bucket so that the bottom or bedrock is being worked toward the bank at all times. In dumping, the bucket is brought over the side and lowered into the hopper but kept slightly above the bottom of the hopper. The load, therefore, is emptied at a height about equal to the length of the bucket. This is rather important, as it helps keep the boat from rocking and on an even keel. Our hull is not unstable when operating and keeps as steady as boats equipped with a bucket line. With this practice we dig and dump twice a minute.

Ample floodlight should be provided for the operator at night when casting out of range of the lights of the boat and all lights on the dredge should be directed so as not to blind the operator's vision.

Very little water is pumped into the hopper to wash the gravel into the screen. There are the two 3-in. discharge pipes, one on each side, discharging toward the front of the hopper, but we keep the valves only partly opened. We find that the feed is maintained evenly if the load in the hopper builds up somewhat, and we let the pressure of gravel at the back of the hopper help push the load into the screen. Thus, the spreading out of the feed at the entrance to the screen is further distributed by the staggered baffle bars inside the screen. Our feed reaches the stacker belt with as even a load as anyone can find on the belt of any bucket-line dredge.

A crew consists of three men—a dredge operator, who acts as shift boss; a dragline operator; and an oiler, who works part time on the dragline and devotes the remainder of his time to the dredge. The shift boss operates the winches and spends most of his time attending to the pumps, jigs, and other equipment.

On the day shift three additional men, a superintendent, a welder, and a shore man, are used. The shore man fuels up the dragline at 4 o'clock in the afternoon or at the end of the day shift and takes care of anchoring the lines and other general work. We are doing away with a regular welder by using detachable dipper teeth. Two of the shift bosses do whatever welding is necessary. The winching on the dragline dredge does not use more than two hours' time out of every 24 hours. The dragline and dredge operator, respectively, make out a separate shift report. This gives the bookkeeper six shift reports per 24 hours, which are compiled on one sheet as a daily report.

Riffles Removed

Late in 1937 we decided to discard riffles and install modern equipment in order to increase gold recovery and save other values occurring as concentrates. The Fisher & Baumhoff dredges in Boise Basin, Idaho, had in the meantime been equipped with Pan American jigs. We had been carrying on some tests by treating a small part of our tailings directly out of the tailing sluice and we were satisfied that we were losing considerable values, not only in free gold but values in the form of sulphides that had been discharged from the mills up Jordan Creek. Our problem was somewhat different than that of the operators of the jig-equipped dredges in Boise Basin and at Warren, Idaho, due to the fact that they had no values worth while left in their concentrates after the concentrates had passed through the amalgamator. Our tailings from the amalgamator revealed values from a few dollars to $200 per ton.

We were assisted in working out our flowsheet by the Pan American Engineering Company, and all jigs installed were of that make. A complete article on this type of equipment is well presented by P. Malozemoff in the September, 1937, issue of *Engineering and Mining Journal*. A flowsheet was determined and necessary changes were made. A water tank 4x4x8 ft. was placed above the "doghouse" to supply a constant head of water to the jigs. The tank contained a sloping screen and is so arranged that grass, fine roots, and other such material cannot get into the discharge pipes. It is necessary to keep such material from entering the jigs between the screen and the spigot discharge, as it builds up in the bottom of the hutch and causes trouble in discharging the concentrates. We have no trouble in keeping the water fairly clean with this arrangement. The tank is kept full of water, so that there is a constant overflow, which is discharged into the trommel. To have additional water for the jig installation, we added a 4-in. pump, which discharges directly into the tank. The 3-in. pump originally on the boat was also made to discharge into the tank, and the two pumps supply about 900 gal. of water per minute.

Even Distribution to Jigs

A new screen was added to take care of the suction pipe from the pumps. It is 3 ft. wide by 4 ft. high by 12 ft. long, made up of 2½-in. angle iron and arc-welded. A ⅜-in. heavy wire screen is fastened across the bottom and on three sides. It is attached to the boat with hinges so that it can be lifted above water without detaching from the boat. Instead of a foot valve on the suction, we use a check valve set at the water level, as it can then be easily cleaned without much loss of time.

The original distributor was discarded and another was installed designed to meet the requirements of delivering the material and water equally to each jig cell. We are able to deliver the same percentage of fines, coarse material, and water into each of the first set of rougher jigs. The distributor is 28 in. wide and runs underneath the full length of the trommel screen. The divisions running crosswise in the distributor are 6 in. apart and are 6 in. high. It is copied more or less after the principle of the Jones sampler. In other words, one half of all screened material drops into another distributor leading directly into the jigs that are placed on one side beneath the trommel screen and the other half is sent to the jigs on the other side. The result is an even distribution of water and gravel. We use slotted baffle plates at the discharge point where the secondary distributor enters each of the four receiving jigs. These slotted baffle plates discharge against a deflector plate which allows the material and water to flow over and into the front edge of the jigs without much fall.

Screened material varies from 40 to 80 per cent of the total gravel excavated. The flowsheet shows that the screened material discharged from each

side of the distributor flows directly into the two 42-in. Placer type jigs placed side by side. Discharge from these jigs flows into another set of jigs of the same size set in tandem and they discharge at the same elevation as the first two. Tailings from these jigs pass through sluices into the pond.

Detail of Jig Operation

Each of these jig cells weighs about 1,600 lb. and has an average height of 68 in. The jig bed is 42x42 in., or about 12.25 sq.ft. of screen area. Each jig with its flow of gravel over the screen adds about 1,000 lb. to the weight of each unit cell. Water required per cell runs from 60 to 120 g.p.m. We are using about 80 gal. at present, but with a larger percentage of fines we increase that amount. Each four-cell block of jigs is driven by a 5-hp. gear motor installed to provide ample power when starting because of the extreme cold weather in this district. When running, however, the four cells consume less than 2 hp. The jigs are set with a speed of 120 strokes per minute. Length of stroke is adjustable and in our practice the jigs are set with a $1\frac{3}{4}$-in. stroke. The pulsation is quite uniform over the entire screen bed and the feed dilution is around 8 to 1 or even higher. Naturally, the dilution is a variable, as the water is kept constant and the feed into the hopper must vary.

Each of the four rougher-cell jigs has a rated capacity of 30 cu.yd. per hour, or a total of 120 cu.yd. of screened gravel per hour. Gravel running 50 per cent minus material will, therefore, permit a feed of 240 cu.yd. per hour into the hopper. It is rather difficult for us to arrive at the concentration ratio on these rougher jigs, but they probably make a ratio of 70 to 1. The first set of cells on each side, or the receiving jigs on each side of the screen, take out approximately 80 per cent of the concentrates from the gravel and the adjoining jigs the remaining 20 per cent. All the rougher jigs discharge their concentrate from the bottom of each cell into a launder leading into a centrally located dewatering tank and sand elevator placed directly underneath the screen. The size of the discharge spigot opening is determined by trial operation. The constant opening we use is $\frac{7}{16}$ in., which is kept uniform by a rubber disk having this size aperture and held in place by the discharge valve. The launders are equipped with water connections to dilute the concentrates in order to make them flow more readily through the launders into the dewatering tank. Our aim is to make a rough concentrate from the first eight jigs and have it contain all the values.

The bottom of the dewatering tank is set about 12 in. below the deck line, so as to give the launders more drop and conserve headroom. The tank is 24 in. wide by 36 in. deep and 60 in. long. It has a baffle plate at the rear end, the top edge being 4 in. below the top of the tank and 6 in. back from the end of the tank. This allows the surplus water to overflow and pass directly into a 4-in. discharge pipe which passes through the hull and out the bottom of the boat. The lower wheel of the elevator is 36 in. in diameter and the upper pulley at the head is 12 in. in diameter. They carry a 7-in. Balata 4-ply belt that moves 47 ft. per minute with $2\frac{1}{2}$x$2\frac{1}{2}$x9 in. angle-iron cleats bolted with elevator bolts. These angles are spaced 6 in. apart and carry the dewatered sand up the trough set at an angle of 45 deg., which discharges into two pulsator cleaner jigs.

The bottom of the launder or trough is lined with heavy belting and fastened down with elevator bolts. It is probably better to have the launder somewhat flatter than the 45 deg., as it will aid the sand to drop off the cleats more readily. If there is a tendency to stick, it can be overcome by either having a small spray of water directed against the cleats at the discharge end or by having the discharge point moved further back under the elevator. This will give it a longer interval of time in which to discharge.

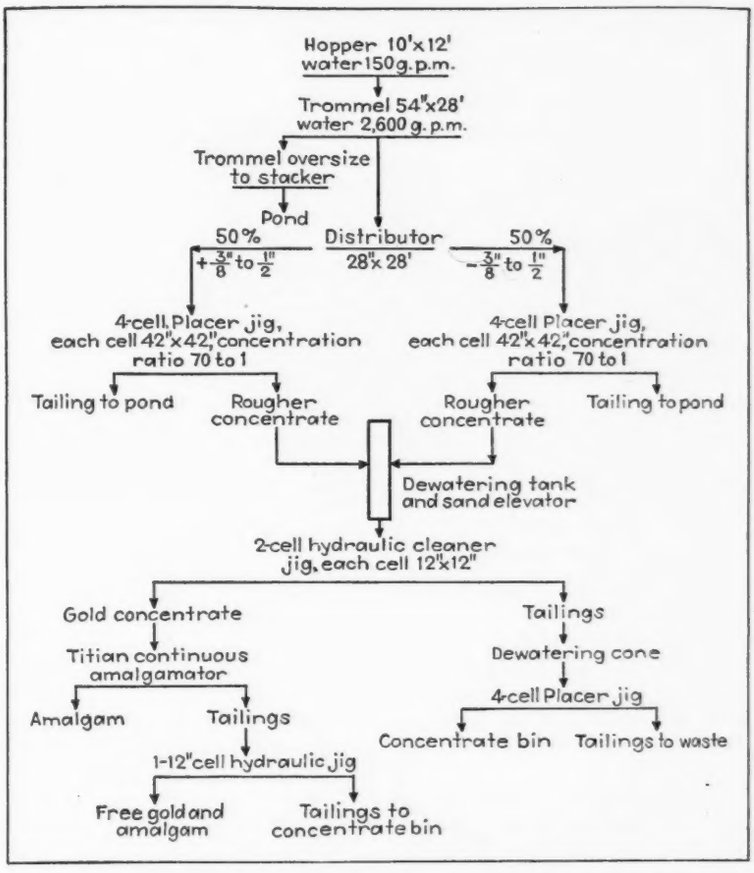


Fig. 2 . . . PLACER JIGS shown in the flowsheet of the dredge recover gold as well as other metal concentrates found in the old stream bed. Water required per jig cell varies from 60 to 120 g.p.m., depending on the quantity of fines

Cleaner Cell

A two-cell pulsator jig (Crangle type) is used as a cleaner and has a rated capacity of $\frac{1}{2}$ to $\frac{3}{4}$ cu.yd. of solids per hour per square foot of screen area, or a capacity of approximately 170 tons of our material per 24 hours. The cells each have a 12x12-in. screen. We operate them at a speed of better than 200 pulsations per minute, and each cell uses from 10 to 20 gal. of water per minute to give the necessary pulsations to obtain the right ratio of concentration. These jigs are making a ratio of concentration of about 1,000 to 1. We use $\frac{1}{4}$- and $\frac{3}{16}$-in. shot and coarse concentrates for bedding.

The cells are set to draw off a minimum amount of concentrates and still contain all the free gold, and amalgam. We recover considerable amalgam from the gravel that escaped from the old mills further up the stream. We make from 100 to 150 lb. of gold concentrate per day, and feel satisfied that the rougher concentrate from the rougher jigs, which feeds into the cleaner jigs, contains all the free

Fig. 3 . . . DOWNSTREAM VIEW of the gold placer area along Jordan Creek. The depth of the gravel varies from 6 to 18 ft., and large boulders are common. Rocks too large for the hopper are deposited behind the dragline and removed by a Caterpillar tractor and bulldozer

gold and all other values in the gravel. We also know that we are getting better than 95 per cent of the free gold in the concentrate from the cleaner jigs.

The gold concentrate from the two cleaner jigs passes directly into a continuous-type revolving amalgamator made by the Mill & Mine Supply Company, of Seattle, Wash. It revolves 40 r.p.m. The inside of the barrel contains six amalgam plates, each 5½x48 in., plated on both sides. The concentrates are impacted against the plates twice with every revolution of the amalgamator, or at the rate of 80 times per minute. I would say that any particle of the concentrates is impacted from 100 to 160 times before it is finally discharged from the machine. If any particle of gold is coated or has the tendency of not amalgamating, the scouring action, together with the number of impacts, will amalgamate the free gold.

Amalgamator Tailings to Jigs

We have a 12-in. one-cell pulsator jig at the tail end of the amalgamator to catch any free gold or amalgam that might pass through the amalgamator, but we find very little gets through. Mercury is fed into the amalgamator at the head end by an automatic mercury feeder which discharges one drop of mercury every 7½ minutes. The size of the drop can be adjusted by a micrometer screw and needs hardly any attention from one week to another.

We plan to clean up every five days or sooner if we think the plates are getting overloaded. In cleaning up, the discharge spout is removed and the core is unlocked from the cylinder and placed endwise in a flat iron pan. We strip the amalgam off the plates into the pan. The plates are dressed and placed back into the barrel. We clean up in about 30 minutes. It took several hours, twice a month, to make a clean-up when we used riffles.

The tailings from the amalgamator, which are concentrates with the free gold removed as stated before, discharge into a 12-in. cell pulsator jig. This is a safety jig used to catch any lose mercury, gold, or amalgam that might break away from the plates. The overflow, or tailing, from this jig goes directly into the concentrate bin.

We now go back and follow the tailings through from the two cleaner jigs at the head of the sand elevator belt. These tailings pass into a cone dewaterer and the spigot from the cone discharges into a four-cell cleaner placer jig. This jig has the same principle of operation as the large rougher jigs, but has a speed of about 240 times per minute and is a cleaner jig. This particular jig is the first one to be permanently installed on any dredge. Each cell is 9 in. square, or the total screen bed for the four cells is 9x36 in. square, and yet it has sufficient capacity to handle all the rougher concentrates and do a first-class job of concentration. The length of stroke is adjustable and we carry a different length of stroke on each cell. The shortest stroke is at the head and the longest at the discharge end. Average stroke is about 1 in.

About 15 gal. of water is added per minute underneath the screen to each cell hutch, and each hutch has its own discharge valve. The tailings pass into the pond and the concentrates into the bin. Our concentrates are reddish in color, carrying around 80 per cent of their weight in garnets. They easily dewater themselves down to 8 per cent moisture. The four cells are operated by a 1-hp. electric motor and we have no trouble with the operation of the jig. The jig bed on all jigs is made up of ¼- and $\frac{3}{16}$-in. steel shot, coarse garnets, sulphides, and placer tin.

In order to move a maximum yardage, simplify the moving of the boat into position, and facilitate digging on bedrock to the best advantage, we keep the edge of the bank dug in a straight line. We have tried several arrangements to satisfy ourselves as to the best. A section of approximately 30 ft. in width is dug at a time (this width may vary according to conditions) across the flat, and we plan to cover bedrock twice in digging across once. The same bedrock is cleaned again as we move back from the opposite direction and at nearly right angles to the first cleaning. The bucket holds itself down fairly well, as its weight empty is around 6,300 lb., and as the bedrock is generally soft we feel that we are doing a good job of bedrock cleaning.

The operator is instructed not to throw the bucket back after pulling it in, to increase the load, but to dump with whatever material he may have in it. We do this so as to not throw back a small quantity of gravel, which may have been dug off bedrock and contain high values in free gold. On the other hand, if it is thrown back on wholly or partly cleaned bedrock, it is almost impossible to pick it up again unless there is still considerable gravel originally left on bedrock. In other words, the operator is instructed to dump whatever is in the bucket regardless of the load.

Jigs Versus Riffles

The percentage of actual running time for our operation equipped with riffles as compared to the operating time when equipped with jigs shows a decided preference for the jig installation. Our actual running time with riffles was from 75 per cent to 80 per cent of the total time. This may be lower than the actual running time on other operations and does not appear very high. As stated before, we had a large number of boulders, and any quantity of large rocks will slow up operations. However, if the lost time on any dredging operation has been carefully recorded, it soon becomes apparent that 80 per cent operating time is a good percentage. Our operating time equipped with jigs runs from 80 to 85 per cent, which is about 5 per cent more running time than we made with riffles. This increase is possibly due to the fact that there is no lost time in cleaning up the gold and concentrates with jigs, which is nearly a continuous operation so far as the boat itself is concerned. Cleaning up on riffles results in considerable loss of time during a month. There was also a loss of time with riffles when a high percentage of fines was encountered in sanding.

No doubt the cost per day for a

period of several months' operation is higher on account of jig repairs than with riffles; but the cost per yard on the same operation would not be any more, and would perhaps be less, with jigs. This is due entirely to the fact that a much larger yardage can be handled with jigs with the same overhead cost. The cost per yard in operating a dragline dredge is usually higher than on a bucket-line dredge and is due to the fact that they are not operating on the same basis. The former is operating, as a rule, on ground that would be difficult ground for the bucket-line dredge and in many instances on ground that would be impossible for any other equipment.

Following is an estimate of costs for a full crew on a dragline operation with a rated capacity of 3,000 cu.yd. per 24 hours.

Table II—Costs for Full-Crew Dragline Operation: 3,000 Cu.Yd. Per 24 Hours

1 superintendent	$10.00	
3 dragline operators at $1 per hour	24.00	
3 dredge operators at 65c per hour	15.60	
3 helpers or oilers at 60c per hour	14.40	
1 welder and general repairman at 80c per hour	6.40	
1 general surfaceman at 60c per hour	4.80	
1 bookkeeper	6.00	
Total labor charge per day	$76.20	$76.20
Dipper teeth maintenance (replaceable)	$5.00	
Dragline maintenance	8.00	
Screen maintenance	3.00	
Unforeseen expense	10.00	
Fuel for dragline	11.50	
Lubricating oil	1.20	
Gasoline	6.00	
Electric power for dredge	12.40	
Total miscellaneous expense per day	$57.10	$57.10
Taxes per day	$2.837	
Federal old age benefit	0.760	
Federal unemployment	0.230	
State unemployment	2.060	
State compensation	2.440	
Total taxes, social security, etc.	$8.33	$8.33
Depreciation per day	$60.00	$60.00
Total expense per day		$201.63
Cost per cubic yard, cents	6.72	
Labor cost per cubic yard	$0.0254	
Power cost per cubic yard	0.0104	
Miscellaneous cost per cubic yard	0.0087	
Depreciation cost per cubic yard	0.0200	
Taxes, etc., per cubic yard	0.0028	
	$0.0673	

We use about 2,500 gal. of fuel oil per month in the dragline and our electric cost will run from $324.25 to $427.45 per month. The cost of electricity will probably run about the same as anywhere throughout our Western States, but we know that our fuel-oil cost is somewhat higher than the average.

Some operators and manufacturers will take exception to statements made in this article and to some of the things we do in our operation, but our conditions govern our practice. What may be the right thing to do, the best type of dredge, and the proper method of operation on our type of deposit perhaps would be improper on another type of deposit. I hope that the article may be of some interest and help to those who have had little experience and are contemplating such an operation. No doubt other operators have discovered many details that would be useful in this particular operation, but, on the other hand, there may be some things merely mentioned in this paper that might be of aid to them.

▼ ▼ ▼

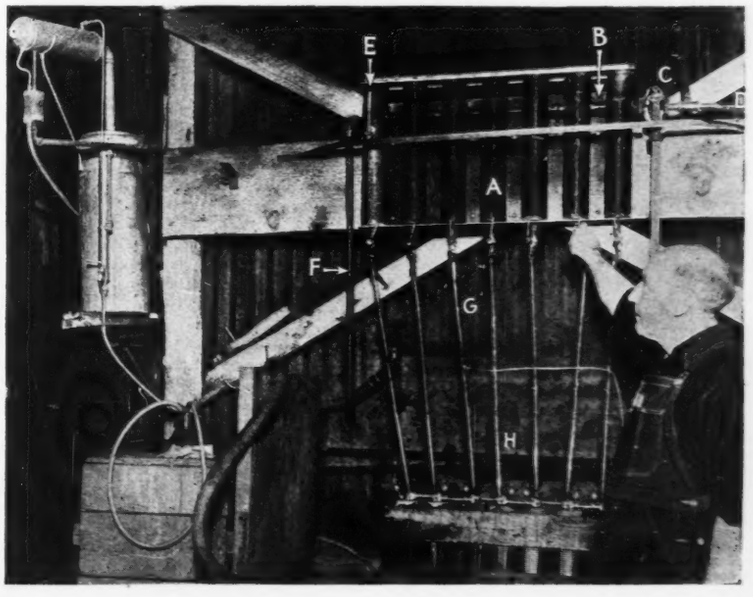
When Changing Electrolyte

ONE OF THE PROBLEMS confronting the mine or smelter electrician at times is that of changing electrolyte in storage-battery cells. This is a job that consumes time if performed by conventional hand methods. At the mines of Anaconda Copper Mining Company, at Butte, Mont., the work is done quickly and effectively by the following arrangement developed by the engineering research department.

The device is capable of charging simultaneously seven or fewer cells from storage batteries and requires but one man to operate it. It consists of seven iron cylinders *A*, each interconnected and attached to the operating valve *C* on inflow pipe *D* by the nipples *B;* a glass gage *E* to indicate the level of the electrolyte for one cell; overflow pipe *F*; and the seven fill pipes *G*. These are made from ½-in. pipe and contain besides the plug valves just below each cylinder two 90-deg. elbows with a short pipe nipple between them and the fill ends *H*. The ½-in. plug valves were made at the machine shop, the already ground fit of the terminal posts on the battery cells being used for the plug and body of the valve. Each sliding fill end *H*, made from ⅜-in. pipe, is reduced at the bottom to ⅛ in. for a distance of about 3 in., so it will fit into the hole in the cell. When not in use, the fill ends are raised and are held in that position by the lug-stops on the ⅜-in. pipe over which they slide. The elbow joints just below the plug valves permit the fill pipes to be moved sideways.

The operation of the arrangement is as follows: A tray of cells is placed in the sink under the device, with each plug valve being shut. The operating valve *C* is then opened, thereby filling each cylinder with electrolyte to the proper level indicated by the glass gage *E* and overflow pipe *F*. After this has been accomplished, valve *C* is closed and the plug valves are opened, thus transferring the amount of electrolyte stored in each cylinder to the corresponding cell in the tray below.

The electrolyte is received in 500-lb. iron drums. It is stored on the floor above the battery room containing the multiple charging device described. The drum resting on a four-wheel castor truck is connected to the main supply line leading to the charging device by means of a ¾-in. pipe union preceded by a short nipple, reducing bushing, and a plug valve.



Summary of the

MARKETS

SENTIMENT in non-ferrous metals underwent a marked change for the better during June. Early in the month the news of sharp curtailment in production seemed to put a definite bottom to prices. This was followed by improvement in buying, which first became visible in lead. From lead, the buying spread to zinc and then to copper. Adjournment of Congress and the Administration's huge spending program set off an extraordinary rise in securities. Operators appeared convinced that the general trend in business again pointed upward. Lead, zinc, and tin prices advanced before the end of June, with copper in process of moving upward as the month ended.

The rise occurred so late in the month that the *E.&M.J.* index, based on monthly averages, did not reflect the market changes. The index for June was 67.55, against 69.15 for May and 93.21 for June last year.

An event of importance in copper was the step taken by the foreign group to reduce output, effective July 1, from 105 per cent of the standard tonnages to 95 per cent, which action strengthened the London market immediately. The domestic quotation held at 9c., Valley, throughout June, though on the last day Phelps Dodge advanced its quotation to 9¼c. There was a rush for copper, and sales on June 30 for domestic account alone totaled 27,594 tons. Sales for June amounted to 87,618 tons, the largest monthly total since December, 1936. On the following day, July 1, the domestic price was raised by all sellers to 9¼c., Valley. The active buying of copper was based almost entirely on prospects of increased business.

Lead was active, even after the price advanced to 4¾c., New York. Prime Western zinc closed the month at 4½c., St. Louis, but moved up to 4¾c. on July 1. Tin was strong on curtailed output and the Buffer Pool. Platinum advanced to $36 per ounce.

UNITED STATES MARKET

1938 June	Electrolytic Copper Domestic (a)	Electrolytic Copper Export (b)	Straits Tin New York	Lead New York	Lead St. Louis	Zinc St. Louis
1	8.775	7.975	37.375	4.00	3.85	4.000
2	8.775	8.125	38.375	4.00	3.85	4.000
3	8.775	8.200	38.750	4.00	3.85	4.000
4	8.775	8.200	38.500	4.00	3.85	4.000
6	8.775	8.350	38.625	4.00	3.85	4.000
7	8.775	8.400	38.750	4.00	3.85	4.000
8	8.775	8.275	38.600	4.00	3.85	4.000
9	8.775	8.325	38.750	4.00	3.85	4.000
10	8.775	8.400	39.475	4.00	3.85	4.000
11	8.775	8.400	39.475	4.00	3.85	4.000
13	8.775	8.325	39.125	4.00	3.85	4.000
14	8.775	8.275	38.700	4.00	3.85	4.000
15	8.775	8.300	39.125	4.00	3.85	4.000
16	8.775	8.300	39.750	4.00	3.85	4.000
17	8.775	8.325	40.875	4.00	3.85	4.000
18	8.775	8.350	41.150	4.00	3.85	4.000
20	8.775	8.450	41.500	4.00	3.85	4.000
21	8.775	8.575	42.000	4.00	3.85	4.000
22	8.775	8.675	42.250	4.25	4.10	4.075
23	8.775	8.825	42.600	4.35	4.20	4.325
24	8.775	8.950	42.900	4.50	4.35	4.500
25	8.775	9.000	42.625	4.50	4.35	4.500
27	8.775	9.050	42.600	4.50	4.35	4.500
28	8.775	9.025	42.250	4.50	4.35	4.500
29	8.775	8.875	42.650	4.50	4.35	4.500
30	8.775	9.050	43.000	4.75	4.60	4.500
For month Average	8.775	8.500	40.376	4.148	3.998	4.131
June			AVERAGES FOR WEEK			
1	8.775	7.950	36.455	4.050	3.900	4.000
8	8.775	8.258	38.600	4.000	3.850	4.000
15	8.775	8.338	39.108	4.000	3.850	4.000
22	8.775	8.446	41.254	4.042	3.892	4.013
29	8.775	8.954	42.604	4.475	4.325	4.471
June			CALENDAR WEEK AVERAGES			
4	8.775	8.100	37.950	4.000	3.850	4.000
11	8.775	8.358	38.946	4.000	3.850	4.000
18	8.775	8.313	39.788	4.000	3.850	4.000
25	8.775	8.746	42.313	4.267	4.117	4.233

SILVER, GOLD, AND STERLING EXCHANGE

NEW YORK AND LONDON

1938 June	Sterling Exchange "Checks"	Sterling Exchange "90-day demand"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
1	4.942500	4.936875	42.750	18.9375	140s 7½d	$35.00
2	4.945000	4.938750	42.750	18.9375	140s 8d	35.00
3	4.944375	4.939375	42.750	19.0625	140s 9d	35.00
4	4.947500	4.941875	(e)	19.0625	140s 8d	35.00
6	4.945000	4.940000	42.750	Holiday	Holiday	35.00
7	4.948750	4.943125	42.750	19.0000	140s 7d	35.00
8	4.954375	4.949375	42.750	18.9375	140s 5½d	35.00
9	4.950000	4.945000	42.750	19.0000	140s 6½d	35.00
10	4.955625	4.950625	42.750	19.0000	140s 7d	35.00
11	4.970000	4.964375	(e)	19.0000	140s 7d	35.00
13	4.966250	4.960625	42.750	18.9375	140s 6½d	35.00
14	4.966875	4.961875	42.750	18.7500	140s 8d	35.00
15	4.976250	4.970625	42.750	18.8750	140s 9d	35.00
16	4.970000	4.964375	42.750	18.8125	140s 10d	35.00
17	4.976000	4.964375	42.750	18.7500	140s 10½d	35.00
18	4.970000	4.964375	(e)	18.6875	140s 10d	35.00
20	4.968125	4,962500	42.750	18.8125	140s 10d	35.00
21	4.957500	4.951875	42.750	18.9375	140s 9½d	35.00
22	4.955625	4.949375	42.750	18.9375	140s 10d	35.00
23	4.958750	4.952500	42.750	18.9375	140s 9d	35.00
24	4.960625	4.953750	42.750	19.0000	140s 10d	35.00
25	4.961250	4.954375	(e)	19.0000	140s 10d	35.00
27	4.953750	4.946875	42.750	19.0625	140s 10d	35.00
28	4.955625	4.948750	42.750	19.0625	140s 9d	35.00
29	4.953125	4.946875	42.750	19.0625	140s 8½d	35.00
30	4.953750	4.948125	42.750	19.0625	140s 8½d	35.00
Average for Mo.	4.95772	.....	42.750	18.945	.....	35.00
June			AVERAGES FOR WEEK			
1	4.94338	.....	42.750	.....	.....	.....
8	4.94750	.....	42.750	.....	.....	.....
15	4.96417	.....	42.750	.....	.....	.....
22	4.96521	.....	42.750	.....	.....	.....
29	4.95719	.....	42.750	.....	.....	.....

Calendar week averages: New York Silver, June 4th, 42.750; 11th, 42.750; 18th, 42.750; 25th, 42.750

(e) Not quoted; Saturday

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.350c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than 1c. over the *Engineering and Mining Journal's* average quotation for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order effective Jan. 1, 1938, the U. S. Government's price on newly mined domestic silver was established at 64.64c. Handy & Harman's quotation for domestic silver, 999 fine, was 64⅛c. per ounce throughout June.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quotated by the Treasury, which at present is equal to $34.9125 per ounce.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1938	COPPER			TIN		LEAD				ZINC			
	Standard		Electro	Standard		Spot		3 months		Spot		3 months	
June	Spot	3 months	Bid	Spot	3 months	Buyers	Sellers	Buyers	Sellers	Buyers	Sellers	Buyers	Sellers
1.....	32.9375	33.1875	37.2500	163.0000	163.7500	13.3125	13.3750	13.4375	13.5000	11.8750	12.0000	12.1250	12.1875
2.....	33.9375	34.1250	37.7500	167.7500	168.2500	13.5000	13.6250	13.6875	13.7500	12.3125	12.3750	12.5000	12.5625
3.....	34.4375	34.6250	38.2500	170.2500	170.7500	13.5625	13.6250	13.6875	13.8125	12.3125	12.3750	12.5625	12.6250
6						Holiday							
7.....	34.8750	35.1875	39.0000	173.0000	173.5000	13.5625	13.6875	13.7500	13.8125	12.4375	12.5000	12.6250	12.7500
8.....	34.4375	34.6875	38.5000	171.2500	171.7500	13.3125	13.4375	13.5000	13.5625	12.3750	12.4375	12.5625	12.6250
9.....	34.1250	34.3750	38.2500	169.7500	170.7500	13.1250	13.2500	13.3125	13.3750	12.2500	12.3125	12.4375	12.5000
10.....	34.9375	35.1250	39.0000	173.0000	173.7500	13.6250	13.6875	13.6875	13.7500	12.5000	12.5625	12.7500	12.8125
13.....	34.5000	34.7500	38.5000	172.2500	173.0000	13.4375	13.5000	13.4375	13.5000	12.3125	12.4375	12.5625	12.6250
14.....	33.6250	33.8750	38.0000	170.0000	170.7500	13.2500	13.3750	13.3125	13.3750	12.3750	12.4375	12.5625	12.6250
15.....	33.9375	34.1250	38.5000	171.2500	172.0000	13.3125	13.3750	13.3125	13.3750	12.3125	12.3750	12.5000	12.5625
16.....	33.7500	33.9375	38.2500	173.7500	174.5000	13.4375	13.5000	13.5000	13.5625	12.3750	12.4375	12.6250	12.6875
17.....	33.8750	34.1250	38.2500	178.5000	179.2500	13.4375	13.5000	13.4375	13.5000	12.4375	12.5000	12.6250	12.6875
20.....	34.6875	34.9375	39.0000	181.5000	182.5000	13.8750	13.9375	13.8750	13.9375	12.6875	12.7500	12.8750	12.9375
21.....	36.1250	36.3750	40.0000	184.0000	185.0000	14.3750	14.4375	14 3750	14.4375	13.0625	13.1250	13.3125	13.3750
22.....	36.1875	36.4375	40.7500	187.2500	188.2500	14.8125	14.9375	14.7500	14.8125	13.4375	13.5000	13.6875	13.7500
23.....	36.6250	36.8125	41.0000	186.2500	187.2500	14.8750	14.9375	14.8750	14.9375	13.9375	14.0625	14.1875	14.2500
24.....	37.3750	37.6875	41.2500	187.5000	188.7500	14.8750	15.0000	14.8750	14.9375	14.0625	14.1250	14.3125	14.3750
27.....	37.8125	38.1250	41.7500	187.2500	188.0000	15.0625	15.1250	15.0000	15.0625	14.0000	14.1250	14.1875	14.2500
28.....	37.1875	37.5000	41.7500	185.2500	186.0000	14.3750	14.4375	14.3750	14.4375	13.2500	13.3750	13.5000	13.5625
29.....	36.6875	37.0000	40 7500	184.0000	185.2500	14.3125	14.3750	14.3125	14.4375	13.4375	13.5625	13.6875	13.7500
30.....	37.8750	38.1875	42.0000	189.2500	190.0000	15.0000	15.1250	15.0000	15.1250	14.0625	14.1875	14.3125	14.3750
Average for Month..	35.235	.....	39.417	177.429	.....	13.969		14.012		12.890		13.104	

Prices for lead and zinc are the official prices for the first session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton of 2,240 lb.

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(July 1, 1938)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb ..... 20c.
Antimony, domestic, spot, lb 11.250
Bismuth, ton lots, lb $1.05
Cadmium, lb ..... 85c. @$1.20
Calcium, lb., ton lots 98 @ 99 per cent ..... 75c.
Chromium, 97 per cent grade, lb ..... 85c.
Nickel, electrolytic cathodes, lb ..... 35c.
Magnesium, 99.8 per cent, carloads, lb ..... 30c.
Palladium, troy oz $24.00
Platinum, (Official quotation) troy oz $36.00
Quicksilver, flask of 76 lb., 100 flasks or more ..... $78.00@$80.00
Radium, mg. radium content $40.00
Selenium, 99.5 per cent, lb $2.00
Silicon, minimum 97 per cent, spot, lb ..... 16.50c.
Tellurium, lb ..... $1.75@$2.00
Thallium, 100 lb. or more, lb $6.50
Titanium, 96 to 98 per cent, lb $6.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton ..... $30.00@$35.00
Chrome Ore, 48 @ 50 per cent, c.i.f. Atl. ports, long ton ..... $24.00@$26.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:
Old Range bessemer $5.25
Mesabi bessemer $5.10
Old Range non-bessemer $5.10
Mesabi, non-bessemer $4.95
Lead (Galena) 80 per cent, Joplin, Mo., ton $52.94
Manganese Ore, c.i.f. Atlantic ports, long ton unit:
52 @ 55 per cent ..... 40c.
50 @ 52 per cent ..... 40c.
44 @ 48 per cent ..... 35c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2 ..... 45c.
Tungsten Ore, per unit of WO_3:
Chinese, 65 per cent, duty paid $18.50
Domestic, 70 per cent and upward ..... (a) $19.00@$20.00
Vanadium Ore, per lb. of contained V_2O_5 ..... 27½c.
Zinc, Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton $30.50
(a) Prices at mines, small lots, usually several dollars less.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb 3c
Cobalt Oxide, 70 @ 71 per cent, lb ..... $1.67@$1.77
Copper Sulphate, 100 lb $4.00
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb $1.42
Sodium Sulphate, bulk, ton ..... $13.00@$15.00

ALLOYS

Beryllium Copper, master alloy, 2.5 to 3 per cent Be, per lb. of contained Be $23.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb ..... 10½c.
Ferromanganese, 78 @ 82 per cent, gross ton $92.50
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo contained. 95c
Ferrosilicon, 50 per cent, gross ton $69.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained $1.70

NON-METALLIC MINERALS

Asbestos, f.o.b. mines, ton:
Canadian (Quebec)
Crude No. 1 ..... $700@$750
Crude No. 2 ..... $150@$350
Spinning fibers ..... $110@$200
Paper stock ..... $40@$45
Shorts ..... $12@$16.50
Vermont
Shingle stock $57
Paper stock $40
Cement stock $25
Barytes, long ton:
Georgia, crude $7.00
Missouri, 90 per cent $BaSO_4$, less than 1 per cent iron ..... $6.00@$7.00
Bauxite, long ton:
Domestic, chemical, 55 @ 58 per cent ..... $6.50@$7.50
Domestic, abrasive, 70 @ 84 per cent ..... $12.50@$15.00
Dalmatian, 50 @ 55 per cent ..... (a)$6.50@$7.50
French, 56 @ 59 per cent ..... (a)$8.00@$9.00
China Clay, f.o.b. mines, ton:
South Carolina and Georgia, No. 1, bulk ..... $6.75@$8.00
Delaware, No. 1 ..... $14.50
Feldspar, bulk, ton:
Potash feldspar, 200 mesh $17.00
Glass-spar, white, 20 mesh $11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton ..... $18@$19
Fuller's earth, f.o.b. Georgia or Florida, ton ..... $7.00@$14.00
Magnesite, per ton:
Dead-burned, f.o.b. California $22.00
Dead-burned, f.o.b. Washington $22.00
Mica, per lb., North Carolina, No. 1 and 2 quality:
1½ x 2 in ..... 15@40c.
2 x 2 in ..... 30@60c.
3 x 3 in ..... 75@$1.20
3 x 4 in ..... $1.00@$1.40
4 x 6 in ..... $2.00@$2.50
White, ground, 70 mesh, ton ..... $60.00@$80.00
Ochet, Georgia, ton ..... $19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports ..... (a) 12@12½c.
Silica, in bags, 325 mesh, ton ..... $18.00@$40.00
Sulphur, Texas mines, long ton $18.00
Talc, f.o.b. works, ton:
New York, double air-floated, 325 mesh ..... $12.00@$15.00
New Jersey, mineral pulp ..... $8.00@$10.00
Vermont, extra white, 200 mesh ..... $9.00@ $9.50
Tripoli, Missouri, ton:
40 mesh, cream colored $14.50
200 mesh, cream colored $26.00
(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:
Bessemer $20.50
Basic $19.50
No. 2 Foundry $20.00
Steel, base prices, Pittsburgh:
Billets, gross ton $34.00
Structural shapes, 100 lb $2.10
Bars, 100 lb $2.25

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1937	1938	1937	1938	1937	1938
January	44.913	44.750	20.734	19.895	490.670	499.895
February	44.750	44.750	20.083	20.159	489.307	501.722
March	45.130	44.446	20.677	20.088	488.412	498.394
April	45.460	42.750	20.740	18.880	491.524	498.046
May	45.025	42.750	20.346	18.731	493.835	496.673
June	44.818	42.750	20.022	18.945	493.404	495.772
July	44.750	.....	19.986	.....	496.582	.....
August	44.750	.....	19.848	.....	498.043	.....
September	44.750	.....	19.889	.....	495.145	.....
October	44.750	.....	19.942	.....	495.395	.....
November	44.750	.....	19.707	.....	499.467	.....
December	44.750	.....	18.835	.....	499.510	.....
Year	44.883	.....	20.067	.....	494.275	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		(a) Electrolytic	
	1937	1938	1937	1938	1937	1938	1937	1938
January	12.415	10.198	12.112	9.908	51.497	41.387	56.288	45.387
February	13.427	9.775	13.828	9.525	59.225	39.597	64.013	43.563
March	15.775	9.775	16.590	9.496	72.339	39.772	76.167	43.582
April	15.121	9.775	14.692	9.443	62.506	39.306	66.614	43.408
May	13.775	9.375	13.999	8.801	61.118	36.668	63.684	40.852
June	13.775	8.775	13.492	8.500	55.696	35.235	61.409	39.417
July	13.775	.....	13.817	.....	56.412	.....	62.807	.....
August	13.775	.....	13.926	.....	57.143	.....	63.595	.....
September	13.530	.....	12.984	.....	52.989	.....	58.966	.....
October	11.838	.....	11.207	.....	45.384	.....	50.619	.....
November	10.797	.....	9.850	.....	39.321	.....	44.023	.....
December	10.006	.....	9.714	.....	39.946	.....	43.886	.....
Year	13.167	.....	13.018	.....	54.465	.....	59.339	.....

New York quotations, cents per pound. London, pounds sterling per long ton, (a) Bid quotation.

LEAD

	New York		St. Louis		London			
	1937	1938	1937	1938	1937 Spot	1937 3 Mos.	1938 Spot	1938 3 Mos.
January	6.000	4.870	5.850	4.720	27.272	27.150	16.135	16.253
February	6.239	4.632	6.089	4.482	28.319	28.328	15.402	15.525
March	7.190	4.500	7.040	4.350	33.027	32.979	15.992	16.075
April	6.175	4.500	6.025	4.350	26.014	25.878	15.579	15.623
May	6.000	4.400	5.850	4.250	24.000	23.891	14.210	14.376
June	6.000	4.148	5.850	3.998	22.878	22.759	13.969	14.012
July	6.000	.....	5.850	.....	23.932	23.703	.....	.....
August	6.452	.....	6.302	.....	22.606	22.670	.....	.....
September	6.400	.....	6.250	.....	20.990	21.044	.....	.....
October	5.740	.....	5.590	.....	18.259	18.318	.....	.....
November	5.033	.....	4.883	.....	16.706	16.714	.....	.....
December	4.875	.....	4.725	.....	15.905	15.994	.....	.....
Year	6.009	.....	5.859	.....	23.326	23.286	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

TIN

	Straits, New York		Standard, Spot, London	
	1937	1938	1937	1938
January	50.925	41.548	229.350	183.619
February	52.010	41.373	233.750	183.144
March	63.043	41.219	282.988	183.473
April	59.172	38.430	267.136	168.612
May	55.651	36.885	250.645	162.693
June	55.851	40.376	249.852	177.429
July	59.245	.....	263.540	.....
August	59.465	.....	264.595	.....
September	58.675	.....	258.943	.....
October	51.654	.....	223.869	.....
November	43.299	.....	190.477	.....
December	43.051	.....	190.449	.....
Year	54.337	.....	242.133	.....

New York quotations cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1937	1938	1937 Spot	1937 3 Mos.	1938 Spot	1938 3 Mos.
January	5.847	5.000	21.153	21.281	14.994	15.173
February	6.465	4.813	25.122	25.322	14.408	14.589
March	7.381	4.417	33.188	33.405	14.364	14.477
April	7.010	4.141	26.216	26.344	13.729	13.919
May	6.750	4.042	23.092	23.365	12.682	12.869
June	6.750	4.131	21.409	21.528	12.890	13.104
July	6.923	.....	22.568	22.693	.....	.....
August	7.192	.....	24.140	24.290	.....	.....
September	7.190	.....	21.406	21.607	.....	.....
October	6.085	.....	17.722	17.955	.....	.....
November	5.630	.....	15.808	15.970	.....	.....
December	5.010	.....	15.274	15.429	.....	.....
Year	6.519	.....	22.258	22.432	.....	.....

St. Louis quotations, Prime Western, cents per pound. London, pounds sterling per long ton.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1937	1938	1937	1938
January	90.000	117.500	19.500	20.000
February	90.000	117.500	19.500	20.000
March	101.667	117.500	20.000	20.000
April	105.000	102.500	20.000	20.000
May	105.000	102.500	20.000	20.000
June	130.962	102.500	20.000	20.000
July	142.500	.....	20.000	.....
August	142.500	.....	20.000	.....
September	142.500	.....	20.000	.....
October	142.500	.....	20.000	.....
November	142.500	.....	20.000	.....
December	132.888	.....	20.000	.....
Year	122.335	.....	19.917	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound, average of producer's and plater's quotations.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1937	1938	1937	1938	1937	1938
January	14.130	13.750	90.250	79.240	50.400	36.000
February	14.563	13.750	91.000	76.455	64.364	36.000
March	16.375	13.750	91.778	72.444	58.000	36.000
April	16.043	13.654	92.000	71.019	58.000	36.000
May	14.830	12.460	95.520	74.640	54.800	33.400
June	14.702	11.731	96.654	80.731	53.000	33.231
July	14.803	.....	93.904	.....	50.115	.....
August	15.327	.....	91.423	.....	51.000	.....
September	16.555	.....	89.020	.....	51.000	.....
October	16.935	.....	86.140	.....	48.560	.....
November	15.848	.....	83.435	.....	43.652	.....
December	14.144	.....	81.038	.....	38.385	.....
Year	15.355	.....	90.180	.....	51.773	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1937	1938	1937	1938	1937	1938
January	21.50	24.50	20.50	23.50	21.00	24.00
February	21.50	24.50	20.50	23.50	21.00	24.00
March	24.20	24.50	23.20	23.50	23.70	24.00
April	24.50	24.50	23.50	23.50	24.00	24.00
May	24.50	24.50	23.50	23.50	24.00	24.00
June	24.50	23.73	23.50	22.73	24.00	23.23
July	24.50	.....	23.50	.....	24.00	.....
August	24.50	.....	23.50	.....	24.00	.....
September	24.50	.....	23.50	.....	24.00	.....
October	24.50	.....	23.50	.....	24.00	.....
November	24.50	.....	23.50	.....	24.00	.....
December	24.50	.....	23.50	.....	24.00	.....
Year	23.975	.....	22.975	.....	23.475	.....

Iron in dollars per long ton. F. o. b. Mahoning and Chenango Valley furnaces.

PERSONAL ITEMS

Dr. M. E. Hurst has been made chief geologist to the Province of Ontario.

A. W. Allen has returned to California from Nazca, Peru.

F. E. Chaon has returned to Canton, S. D., from San Juancito, Honduras.

Richard W. Unger is now mill superintendent for Le Roi Mines Company at Jackson, Calif.

Hedley S. Fowler has gone to Georgetown, British Guiana, from Carcross, Yukon Territory.

J. A. Hemner, formerly at the Yellow Aster mine, Randsburg, Calif., is now at Redding, Calif.

Kingsley Nicolson, of Kellogg, Idaho, is now with the Cactus Mining Company, Rosamond, Calif.

W. W. Watson, metallurgist, Miami Copper Company, Miami, Ariz., is now at Hibbing, Minn.

Sydney H. Ball, of the firm of Rogers, Mayer & Ball, was recently in Canada on a short professional trip.

Harold B. Ewoldt, formerly superintendent, Boulder Fluorspar and Radium Company, is in Deadwood, S. D.

G. C. Earl, engineering executive for Utah Copper for nearly 30 years, has been appointed chief engineer for the company.

Henry S. Sweet has become general superintendent and resident manager of the Roseklip Mines Company, at Bodie, Mono County, Calif.

B. W. Stewart, recently with the Basin Montana Tunnel Company, is now with the Annie Laurie Mines, Sevier, Utah.

L. P. Entwistle, mining engineer of the American Smelting & Refining Company, has left Tucson, Ariz., and is now at Vanadium, N. M.

W. A. Fealy is at Eagle Shawmut mine, Chinese Camp, Calif., having recently left the Southwestern Graphite Company at Burnet, Tex.

H. F. Mills, recently manager of the Mutual Coal Company, Gallup, N. M., can be reached at the Iron King Mining Company, Humboldt, Ariz.

W. R. Landwehr, geologist for the American Smelting & Refining Company, has been elected chairman of the Utah section of the A.I.M.E.

J. C. Kinnear, manager for Nevada Consolidated at McGill, Nev., has sailed with his family for a vacation in England, Scotland, and France.

A. R. Kirchner, mill superintendent with Minas de Matahambre, Cuba, has resigned after fourteen years of service. His future address is 3045 South Sherman St., Englewood, Calif.

Gordon Brown, geologist and associate of **A. G. Langley,** is directing preliminary work at the Rand group of Cariboo-Thompson Gold Mines, Ltd., south of Wells, B. C.

Ernest A. Hersam, of Berkeley, Calif., has retired from his post as professor of metallurgy emeritus, after 45 years of continuous service, on the faculty of the College of Mining, University of

ERNEST A. HERSAM

California. He is succeeded in office by **Dr. Lionel H. Duschak**, for several years superintendent of the Berkeley Experiment Station of the United States Bureau of Mines and since 1921 consulting chemical and metallurgical engineer, with headquarters in San Francisco.

Ira B. Joralemon, mining engineer, of San Francisco, recently left New York, accompanied by members of his family, for an extensive tour of Europe.

L. H. Van Loon has resigned as mill superintendent for God's Lake Gold Mines, Ltd., to become mill superintendent for Madsen Red Lake Gold Mines, Ltd., Red Lake, Ontario.

Robert D. Longyear, president of E. J. Longyear Company, Minneapolis, Minn., has left for Fairbanks, Alaska, on a two months' business and professional trip.

Mack C. Lake, consulting geologist and mining engineer, announces the removal of his office to 400 Call Building, 74 New Montgomery St., San Francisco.

Raymond Lynn Patterson has been elected vice-president in charge of development of Hardy Metallurgical Company, 415 Lexington Ave., New York City.

Prof. Kenneth H. Donaldson has been appointed head of the department of metallurgical engineering in the Case School of Applied Science, Cleveland, Ohio.

A. G. Ballachey has returned to Brantford, Ont., Canada, from the Philippine Islands, where he was mine superintendent for Antamok Goldfields Mining Company.

Dr. M. E. Wilson and **Dean J. J. O'Neill** have been selected president and vice-president, respectively, of Section IV (geology) of the Royal Society of Canada.

James M. McDonald, formerly mining engineer for Kennecott, Granby Consolidated, and Bralco companies, is now manager of the Cariboo Hudson gold mine, at Wells, B. C.

N. H. Atkinson has returned to Canada from Bolivia, where he was superintendent of the Cia. Minera Unificada del Cerro de Potosi, and is now at the Hallnor mine, Pamour, Ont., Canada.

Robert D. Ferron is now at Huanuni, Bolivia, having accepted the position of manager in Bolivia for the Bolivian International Mining Corporation, which operates a tin dredge and concentrator on the Huanuni River.

Horace Moses, who formerly had been in charge of mining at Chino, has succeeded **R. B. Tempest** as general manager of the Chino unit of the Kennecott Copper Corporation, Hurley, N. M.

Prof. H. E. T. Haultain, for 30 years head of the department of mining engineering at the University of Toronto, has resigned. He has been succeeded by **C. G. Williams,** for twelve years general superintendent of Hollinger Consolidated.

J. V. Claypool, of Hibbing, Minn., assistant superintendent of the Hibbing-Chisholm district, has been transferred to Duluth, Minn., as assistant manager of industrial relations for the Oliver Iron Mining Company.

Carl Tolman, mining geologist, of Washington University, St. Louis, Mo., is spending the summer on geological work in the gold belt of western Quebec, in the employ of the Quebec Bureau of Mines.

T. Norton Youngs, formerly a member of the staff of Ymir Yankee Girl Gold Mines, Ltd., Ymir, B. C., has been appointed manager of the Quesnelle Quartz mine at Hixon Creek, B. C.

John Goss, Toronto mining engineer, has been placed in charge of operations at the B X property, Zeballos, B. C., owned jointly by Connell Mining & Exploration Company, Ltd., and the Farris Syndicate.

James O. Greenan, for several years consulting engineer for Marsman & Company, operating in the Philippines, and manager of that company's Southern Division, has returned to the United States with his family and will reside in Carmel, Calif.

Henry E. Doelle, manager, and **Lou J. Fogle,** mill superintendent of Sheep Creek Gold Mines, Ltd., Salmo, B. C., have assumed similar duties at the adjacent Gold Belt mine under an arrangement between the two companies. Mr. Fogle is in charge of the construction of a 150-ton mill at the Gold Belt.

R. N. Hunt has assumed charge of the United States Smelting, Refining & Mining Company's Western explo-

ration department, with offices at 1111 Newhouse Building, Salt Lake City, Utah. Mr. Hunt had previously been employed by the same company as a geologist and in a consulting capacity.

Foster Cline, regional administrator in the Denver, Colo., office of the Federal Securities and Exchange Commission, has presented his resignation, to take effect as of July 1.

Howard N. Lary, geological engineer, a member of the staff of the Federal Securities and Exchange Commission, Denver, Colo., regional office, will on July 1 assume the post of Denver regional administrator, succeeding Foster Cline.

Bela Low, engineer of mines, sailed from New York for Europe on June 22, on a combined business and pleasure trip which will take him to France, Switzerland, Italy, Belgium, Holland, and England. He is accompanied by Mrs. Low. They expect to return in September.

W. G. Lundstrum has become general superintendent of the operations of Falls Creek Mines, Inc. The property is near the east shore of Lake Pend Oreille, its postoffice address being Granite Creek, Idaho. The mines produce ore containing silver, lead, and a small amount of zinc.

John Knox, general manager of Hollinger Consolidated, has been elected president of the Ontario Mining Association for the new year. **Ernest Craig**, general superintendent of Falconbridge Nickel, becomes first vice-president and **R. A. Bryce**, president and consulting engineer for Macassa Mines, second vice-president.

B. M. Synder, mining engineer, of 117 South Sycamore Ave., Los Angeles, has been in San Francisco attending a trial in Judge Trabucco's court, in which he appeared as a witness for the plaintiff in a suit concerning the Pine Grove Gold Mines, near Yerrington, Nev.

Glen L. Bateman, of Edward L. Bateman (Pty), Ltd., Dorr-Oliver representatives in South Africa, sailed from New York on May 18 for London, England. His sailing completed a three months' stay devoted to a review of latest United States manufacturing methods and to inspection of leading metallurgical mills and sanitary treatment plants.

Harry B. Meller on June 13 received the honorary degree of doctor of science from the University of Toledo. Dr. Meller is managing director of Air Hygiene Foundation, an organization for the advancement of industrial health. He is a Senior Fellow at the Mellon Institute, Pittsburgh, and has been in charge of air hygiene research for twenty years.

Earl Thomas Hayes, of Mullan, Idaho; **Carl Kerby Stoddard**, of Reno, Nev.; **Arthur Russell Taylor Denues**, of Pittsburgh, Pa.; and **Francis Miles Bower**, of Mount Ranier, Md., have been appointed to cooperative fellowships at the University of Maryland by joint appointment of **Dr. John W. Finch**, director of the Bureau of Mines, and **Dr. H. C. Byrd**, president of the University of Maryland.

Alfred Chester Beatty, an alumnus of Columbia School of Mines, class of 1898, and **Gano Dunn**, also an alumnus of Columbia and of the College of the City of New York, were awarded degrees of bachelor of science at the recent commencement exercises of Columbia University.

William R. Chedsey, director of the Missouri School of Mines and Metallurgy, was awarded the honorary degree of doctor of engineering at the recent commencement exercises of the Colorado School of Mines, at Golden, Colo., for distinguished service in engineering education. Dr. Chedsey was graduated from the Colorado School of

WILLIAM R. CHEDSEY

Mines in 1908. Following several years of practical field experience in the West, Alaska, and Central America, he entered the profession of teaching. He was for 21 years head of the mining department of Pennsylvania State College, coming to the Missouri School of Mines as director last September.

Dr. H. C. Rickaby, geologist, has been appointed Deputy Minister of Mines for Ontario, succeeding the late Thomas F. Sutherland. He is an alumnus of the University of Toronto. In 1927 he joined the Department of Mines as a geologist and since 1934 he had been acting as provincial geologist.

D. M. Kelly, vice-president in charge of Western operations for the Anaconda Copper Mining Company, was a passenger on board the ill-fated "Olympian" when it plunged into the flood waters of Custer Creek, in eastern Montana, shortly after midnight of June 19. Mr. Kelly was uninjured, as he occupied one of the rear cars which remained on the track.

Donald B. Gillies, vice-president of the Republic Steel Corporation, has been nominated for president and director of the A.I.M.E. for the year ending February, 1939. Among other officers and directors indorsed by the nominating committee were: **Henry Krumb**, consulting mining engineer, New York, vice-president and director, and **C. A. Fulton**, president Southern Phosphate Company; **Charles Camsell**, Deputy Minister Canadian Department of Mines and Resources; **J. T. Mackenzie**, manager American Smelting & Refining Company, East Helena, Mont.; and **F. A. Thompson**, president Montana School of Mines, Butte, Mont., directors. The Committee on Barodynamic Research, through **Gerald Sherman**, chairman, urged that the Emergency Foundation be advised that the board of directors of the A.I.M.E. recommend the continuance of the grant for another year to **P. B. Bucky**, of Columbia University, subject to the supervision of a committee of the Institute. The committee's recommendation was adopted. **T. T. Read** is reappointed representative of the Institute on the Engineering Societies' Library Board for four years. To succeed **Harrison Souder**, who died on May 31 last, **H. M. Roche**, consulting engineer, Dover, N. J., was elected chairman of the Committee on Eastern Magnetite Mining and Milling Methods, on which he formerly served as vice-chairman.

▼

OBITUARY

W. E. Renshaw, well-known Idaho Springs mining man, was killed in an auto accident on June 1.

James Copland, a pioneer in Canadian mining, died recently in Grand Forks, B. C., at the age of 99.

L. J. Tavener, representative in the United States of the International Tin Research and Development Council, died on May 29 in Orange, N. J., at the age of 46.

John A. Backus, of Coleraine, Minn., general foreman for the Oliver Iron Mining Company in the Canisteo district, died on May 7 at the age of 51.

Charles E. Schwarz, consulting mining and metallurgical engineer for St. Louis Smelting & Refining and for National Lead and its subsidiaries, died in St. Louis on June 1 at the age of 64.

H. C. Jennison, manager of the metallurgical department of the American Brass Company, at Waterbury, Conn., died recently in that city at the age of 54.

Frank Bursley Taylor, geologist, died early last month at Fort Wayne, Ind. Mr. Taylor was 77 years old. He was a graduate of Harvard and was formerly in the glacial division of the United States Geological Survey.

Thomas H. Oxnam, of Los Angeles, Calif., chief engineer of Royal Paracale Mines, Inc., of Balete, Masbate, P. I., and special consultant on design and construction of plants for Masbate Consolidated Mining Company, died on May 28 at Rio Guinobatan, Masbate, P. I.

A. Charles Meagher, who in 1906 became mechanical engineer for Utah Copper Company, died in Los Angeles on May 11. He was a native of Richmond, Va., but spent the latter years of his life, with the exception of time spent

(Continued on p. 62)

How to cut haulage cost need not be a difficult problem...

The long life of an Exide-Ironclad saves money in two distinct ways

Exide
IRONCLAD
BATTERIES
With Exide **MIPOR** Separators
"MIPOR," Reg. U. S. Pat. Off.

SERVICE records of Exide-Ironclad Batteries in mining, quarrying and tunneling operations consistently tell the same story. These are long-life batteries that stand up under the toughest conditions underground, bringing giant power to bear on every job you can give them.

In specific terms, the long life of these batteries means a twofold saving. By outlasting their guarantee, they substantially lower the cost of hauling, spreading the battery investment over an unusually long period of time. By keeping renewals years apart, they cut down the incidental expenses that always accompany failure and replacement of a battery.

These facts add special value to the outstanding performance of Exide-Ironclads. Not only do you pay no premium for the type of haulage service they give you, but in the vast majority of cases Exide-Ironclad performance costs you materially less. That explains why Exide-Ironclads are the most widely used batteries for underground haulage today. Write for free booklet, "The Storage Battery Locomotive for Underground Haulage."

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

(Continued from p. 60)

in South America, in the Far West in the mining industry.

James Morrison Dikeman, mining engineer, who died at the Dikeman ranch, in Penn Valley, Calif., on Feb. 25 last, had been prominently identified with mining interests since 1889. His father, G. H. Dikeman, was also a mining engineer, and was largely responsible for assembling and purchasing the claims that constituted the Liberty Bell mine, at Telluride, Colo., a noteworthy producer of gold. James Morrison Dikeman had assisted in mapping and charting Death Valley, when on the staff of the United States Geological Survey; was in the Coeur d'Alenes in the years of the violent labor wars in that district; and had been consulting engineer to United Rhodesian Gold Fields.

▼ ▼ ▼

Letters

Wanted: Better and Cheaper Tunnel-Driving Method

The Editor:

IN THE forty years that I have been active in mining affairs, every single branch of the mining industry has advanced prodigiously except mining. It is true that machine drills have been greatly improved, that explosives have been bettered, and that the mechanical mucker and other contrivances have been invented or improved, but other conditions have offset the advantages gained thereby, with the net result that it costs just as much to drive a drift or tunnel today, and requires nearly as much time, as it did forty years ago.

By comparison the metallurgy of today is so advanced, in so many different directions, that I hesitate to summarize the net advance in technic and cost, but will hazard the guess that metallurgy is four times as efficient today as it was forty years ago.

The oil drillers have done much better than this. Forty years ago, with what was then called a "standard rig," a hole could be drilled through sandstone of average hardness at the rate of 5 ft. per day. Nowadays, the same hole can be drilled with a rotary rig, having bits tipped with stellite or other hard alloy, at the rate of 100 ft. per day. Cost per day is about twice as much as forty years ago, so there is a net advancement of ten to one.

J. B. Newsom has applied core drilling to shaft sinking at the Idaho Maryland mine, in California, and registered a very important departure from time-honored methods. Possibly core drilling may help the tunnel driver, if properly applied.

To give an idea of the rewards that await the inventor of an improved tunneling machine or method, I will itemize the tunnel projects that I happen to know about:

	Miles
Colorado River-Big Thompson project	20
Blue River-Reclamation Bureau outline	30
Blue River-City of Denver project	19
Colorado highway tunnels	2
Colorado mining and drainage tunnels	27

Every state in the Union and every nation in the world has its tunnel projects. New York City recently let a contract for $10,000,000 for a tunnel, being part of the Catskill aqueduct project.

Literally hundreds of millions of dollars will be spent in the next few years for tunnels.

Even if speed could be materially increased without economy of cost, great numbers of tunnels would be built which now are simply in the blueprint stage. City administrations do not like to start a project which cannot be finished within the political life of the administration, and irrigation districts cannot sell bonds to pay interest for a long term of years while waiting for water.

About 1908 there was quite a spurt in building tunnel-machines. Some notable trial runs were recorded. Now that the visible rewards are enormously higher, I hear of few new methods of drifting or tunneling, and nothing having proven advantage.

I want to stress the personal element at this juncture, I am like the immortal Will Rogers in this respect. "All I know is what I read in the papers."

It occurs to me that human invention may not have been as laggard in tunneling as it appears to me to be, and I am sure that the *Engineering and Mining Journal* will follow its time-honored custom of giving world-wide publicity to any substantial and worthy inventor, or improver, of tunneling methods or machines. It is in the hope of unearthing something new and important that I write you.

GEO. J. BANCROFT.
Consulting Engineer of
Williams Fork project.

Denver, Colo.

Metaphosphates in Flotation

The Editor:

A SERIOUS ERROR of fact occurs in Dean Fahrenwald's review of ore dressing in the February issue. On page 80, he notes a recent reference to the use of sodium meta-phosphate as a depressant in flotation, but has failed to recognize the profound difference between meta- and ortho-phosphate. Designating the reagent simply as "phosphate," he states that it was used "many years ago as a depressant for sphalerite."

As co-inventor with E. H. Rose in the use of metaphosphates in flotation, I should like to point out that these reagents were never used in flotation prior to our discovery, on which patent was granted in May, 1936. In fact, they have only recently become commercially available, and previously existed only as laboratory curiosities.

There are three phosphoric acids. The distinction between them is apparent when their formulae are written as derivatives of phosphoric anhydride:

Meta-phosphoric acid HPO_3 $P_2O_5.H_2O$
Pyro-phosphoric acid $H_4P_2O_7$ $P_2O_5.2H_2O$
Ortho-phosphoric acid H_3PO_4 $P_2O_5.3H_2O$

Sodium metaphosphate has properties totally different from those of sodium ortho-phosphate. Most notable of these is that it forms un-ionized complexes with calcium, magnesium, and certain other cations, preventing their precipitation, whereas the ortho-phosphates precipitate these directly. In soap flotation, the action of the meta-phosphates can be looked upon as being closely analogous to the action of cyanides in sulphide flotation, and the effect upon froth collection is equally pronounced.

Within the past two or three years, sodium meta-phosphate has received widespread attention in the treatment of boiler waters and in the textile and laundry trades, where prevention of the precipitation of certain salts is desired. In these applications, the action would be almost exactly the reverse of what Dean Fahrenwald evidently had in mind.

Because for so many years the salts of ortho-phosphoric acid were the only phosphates in extensive commercial use, the word "phosphate" has been inaccurately but generally adopted as meaning ortho-phosphate, but with recent advances in technology a careful distinction in terminology is very necessary.

W. T. MACDONALD
Copper Cliff, Ont., Canada.

Assessment Work Should Be Performed

The Editor:

I RESPECTFULLY DEMUR to the conclusions of the article, under this heading, in your April issue.

Last year, and for the two preceding years, it seemed to me, as to many others, that there was insufficient reason for suspending the requirement of assessment work. This year the situation is entirely different. The price of all base metals is so low that employment, except in the gold districts, is scarce, and the effect of the depression is acute. So far as this State is concerned, the new price for silver is unremunerative. The threat of a further fall in lead and zinc, if the present tariff is changed, and the prospect of increased costs due to increase in freight rates—which the miner will have to pay either directly or indirectly—all tend to make a bad situation worse.

The argument that the requirement of assessment work will provide needed employment is, I think, mistaken. All who can afford it have long been accustomed to patent their claims, unpatented locations being rarely regarded as good title, excepting for the original locator. Few corporations, or people with means, own unpatented claims. Those who do rarely have any money with which to employ anybody to do assessment work.

Denver, Colo. GEORGE E. COLLINS

What Metal Statistics Show

GREATER activity in security and metal markets during the last two weeks of June has brightened the outlook for the mining industry during the remainder of the year. Kennecott Copper Corporation announced on July 1 that production at its Utah property is tentatively planned to be resumed on Aug. 1, following a shutdown since June 16. Remaining mines of that company, however, will remain virtually shut down, while other producers continue production schedules on a drastically curtailed basis in view of the large stocks existing above ground. Should actual consumption of copper, however, steadily increase above the current rate (average 40,000 tons monthly), during the remainder of the year, as the recent buying wave appears to anticipate, production schedules during the last quarter should show a marked improvement.

Rising prices of lead and zinc from recent unprofitable levels have encouraged the industry and producers see propects of improving the statistical position of these metals in the near future. Activity in the Tri-State area is beginning to increase, and conditions generally are expected to improve in these industries during the remainder of the year.

Following is a summary of the April and May statistics of the Copper Institute, in short tons, covering foreign and domestic operations:

	April	May
Production (blister):		
U. S. mine	42,028	38,356
U. S. scrap, etc.	8,913	10,720
Foreign mine	91,267	94,421
Foreign scrap, etc.	13,129	12,714
Totals	155,337	156,211
Production refined:		
United States	55,749	47,300
Foreign	106,839	102,044
Totals	162,588	149,344
Deliveries to customers:		
Domestic	31,684	28,044
Foreign	129,577	108,523
Totals	161,261	136,567
U. S. exports of domestic copper	11,187	5,110
Stocks refined:		
United States	355,663	369,809
Foreign	185,916	184,547
Totals	541,579	554,356

▶LEAD—On July 7 a labor strike at the East Helena lead smelter of the American Smelting & Refining Company, in Montana, caused suspension of operations.

Domestic shipments of refined lead to consumers during May turned out to be slightly higher than in April, and, with production smaller, the gain in stocks, amounting to 7,008 tons, was not as large as expected.

The American Bureau of Metal Statistics' figures on refined lead for April and May, in short tons, follow:

	April	May
Stock at beginning	143,511	156,715
Production:		
Domestic ore	37,997	31,918
Secondary and foreign	1,294	1,059
Totals	39,291	32,977
Domestic shipments	25,952	26,011
Stock at end	156,715	163,723

▶ZINC—The May and June statistics of the American Zinc Institute, covering all grades, are summarized as follows in short tons:

	May	June
Production	37,510	30,799
Production, daily rate	1,210	1,027
Shipments	24,628	29,248
Stock at end	148,120	149,671
Unfilled orders	23,444	41,785

Statistics of the Prime Western division, common grades only, for May and June, follow:

	May	June
Stock at beginning	58,079	64,667
Production	20,537	14,657
Shipments	13,949	12,649
Stock at end	64,667	66,675

Deliveries of Copper for Consumption Ex U.S.A.

(Not Including Japan and Russia)

(In Metric Tons)

American Bureau of Metal Statistics

	1936 (a) Average per Month	1937 (a) Average per Month	1938 Average per Month	1938 Number of Months	1938 Average last 3 Months
Canada (b)	3,817	4,650	4,100	4	3,900
Great Britian	21,542	25,342	22,700	5	24,100
France	9,450	9,983	9,746	4	9,429
Germany	15,275	18,983	24,281	4	24,130
Italy	6,975	6,442	7,881	4	7,779
Austria	958	1,500	866	4	1,020
Czechoslovakia	2,408	2,542	2,250	4	2,626
Netherlands	408	675	646	5	763
Poland	1,183	1,442	1,931	4	1,852
Sweden	3,692	4,192	3,780	4	3,879
Switzerland	1,000	1,692	1,730	5	1,690
Other Europe	5,501	6,149	*6,100	..	*6,100
India	683	791	657	3	657
Elsewhere	2,458	2,625	*2,600	..	*2,600
Total metric tons	75,350	87,008	89,268	..	90,525
Total short tons	83,058	95,909	98,400	..	99,786

* Conjectural. (a) Monthly average for year as per A.B.M.S. annual. (b) The credits to Canada in 1938 include rods, etc., exported (which do not appear in the debits to other countries whither exported), to which is added an estimated figure for strictly domestic consumption.

Gold Production of the World 1937-1938

American Bureau of Metal Statistics

(Thousands of Fine Ounces)

	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jan.-May
United States (a)	398	361	320	367	352	392	1,792
Canada	362	361	341	376	368	385	1,831
Mexico	59	85	65	*75	*75	*70	370
Colombia	32	42	34	40	48	*41	205
Chile	31	23	24	19	*26	*22	114
Other America	65	68	70	72	72	74	356
Europe (b)	45	45	47	44	44	45	225
British India (c)	29	27	27	27	26	27	134
Japan (c)	*60	*60	*60	*60	*60	*60	300
Other Asia	90	90	90	90	90	94	454
Queensland	17	10	11	12	12	12	57
Western Australia	97	86	97	89	95	92	459
Other Australia	25	26	27	25	29	30	137
New Guinea	17	17	16	16	17	17	83
New Zealand	17	10	12	16	13	15	66
South Africa	991	988	929	1,015	983	1,019	4,934
Belgian Congo	40	40	40	35	38	38	191
Rhodesia	67	68	64	68	68	68	336
British West Africa	57	60	56	60	60	62	298
Other Africa	33	34	32	33	35	40	174
Totals ex Russia	2,532	2,501	2,362	2,539	2,511	2,606	12,516
Totals ex Russia previous year	2,484	2,405	2,262	2,421	2,374	2,497	11,959

*Conjectural. (a) Includes Philippines. (b) Exclusive of Russia; accounts chiefly for Sweden and Rumania. (c) Principal mines only, but nearly complete. Owing to governmental interdiction the accounting for Japan is now necessarily on the assumption that it is being maintained about at prior rate.

Gravel-treating plant of the Gertrude Mining Exploration Company at Stent, Calif. Gold-bearing material is mined by power shovels and large power scrapers and transported by trucks

CALIFORNIA

Argonaut Mine Prepares For Operations

Effects of mine fire expected to be cleaned up soon—All-jig dragline dredge starts operation near Cottonwood—Quicksilver mine near Parkfield being reopened

▶ Dewatering and clearing operations are proceeding according to schedule at the Argonaut mine, at Jackson, Amador County, which has been idle since February because of an underground fire. Alex. F. Ross, general superintendent, expects the work to be completed in a month. At the adjoining Kennedy property (also closed down during the fire) 25 men are now employed on development work under William Sinclair, superintendent.

▶ Work has been resumed at the Sliger mine, near Georgetown, owned by the Middle Fork Gold Mining Company, C. W. Plumb, superintendent, after a brief shutdown following relinquishment of option by Mountain Copper Company, which deepened the main shaft to 1,400 ft., apart from some lateral development work. About 40 men are employed.

▶ Gold Acres Dredging Company has placed in operation an all-jig dragline dredge near Cottonwood. The floating washing plant can handle 150 yd. of gravel an hour, and was built by Bodinson Manufacturing Company, of San Francisco. H. Ardelle is president of Gold Acres Dredging Company.

▶ Golden Queen Mining Company, W. C. Browning, general manager, Mojave, reports completion of the new tunnel for hauling ore from the neighboring Soledad Extension property to the Golden Queen mill. It was started on the 600-ft. level of the Golden Queen mine and is about 3,500 ft. long. A spur is now being driven from the tunnel to the Lodestar mine to facilitate transportation of ore mined there to the Golden Queen mill. Charles Kumke, superintendent, directs operations at the Golden Queen mine.

▶ A. B. Adams is directing operations at the Kentucky Ridge mine, in the Newtown district near Grass Valley, where a five-stamp mill was erected recently. The mill is working one shift, treating ore mined in the 400-ft. English tunnel. If the option on the property granted by Adams is not exercized, operations are expected to be placed on a 24-hour basis.

▶ Installation of the new 150-ton flotation mill at the Scotia shaft of Golden Center Mining Company, Grass Valley, has been completed. The stamp mill at the Golden Center mine will be closed down and all ore mined in the Scotia and Golden Center mines will be treated exclusively at the new plant. William Carey is superintendent, and the properties are owned by the Cooley-Butler interests, of Los Angeles.

▶ Leasers headed by C. Nugent and assisted by the Empire Star Mines Company are reported to be opening the Osborne Hill mine, near Grass Valley. The old shaft, partly filled with water, is to be reconditioned as a preliminary to examination and subsequent development work.

▶ About 54 men are now employed at the Norambagua mine, near Grass Valley, operated by the Campbell Grass Valley Mining Company. The 50-ton mill is operating twenty hours a day treating development ore. George W. Worthington, general manager, is in charge of operations.

▶ Work has been started on a new flotation mill at the Washington mine, French Gulch, operated under lease and option by the J. H. Scott Company, of San Francisco, and milling operations are scheduled to start in August. Austin Merrill is superintendent.

▶ The Franciscan quicksilver mine, near Parkfield, also known as the Patriquin, is being reopened and the 50-ton reduction plant reconditioned by Monterey interests which hold a lease and option on the property. R. J. McEwen is in charge of operations.

▶ Burton Brothers, of Rosamond, and their associates, operating the Ruth mine and the Davenport claims in the Argus mining district about 14 miles north of Trona, are reported to have acquired the Sunrise-St. Patrick mine, in the same locality. Equipment at the Ruth mine includes a cyanide leaching plant, which is currently handling about 70 tons of ore a day. At the Davenport property nearly 1,000 ft. of development work has been completed recently, exposing a fair tonnage of milling ore which may be sent to the Ruth mill for treatment.

▶ Operations are to be resumed at the Gwynne mine, 50 miles north of Mojave, following the winter shutdown. The property is equipped with a 25-ton mill and is owned by Geringer Brothers, of Mojave, who obtained a $20,000 RFC loan last year to develop the mine.

UTAH

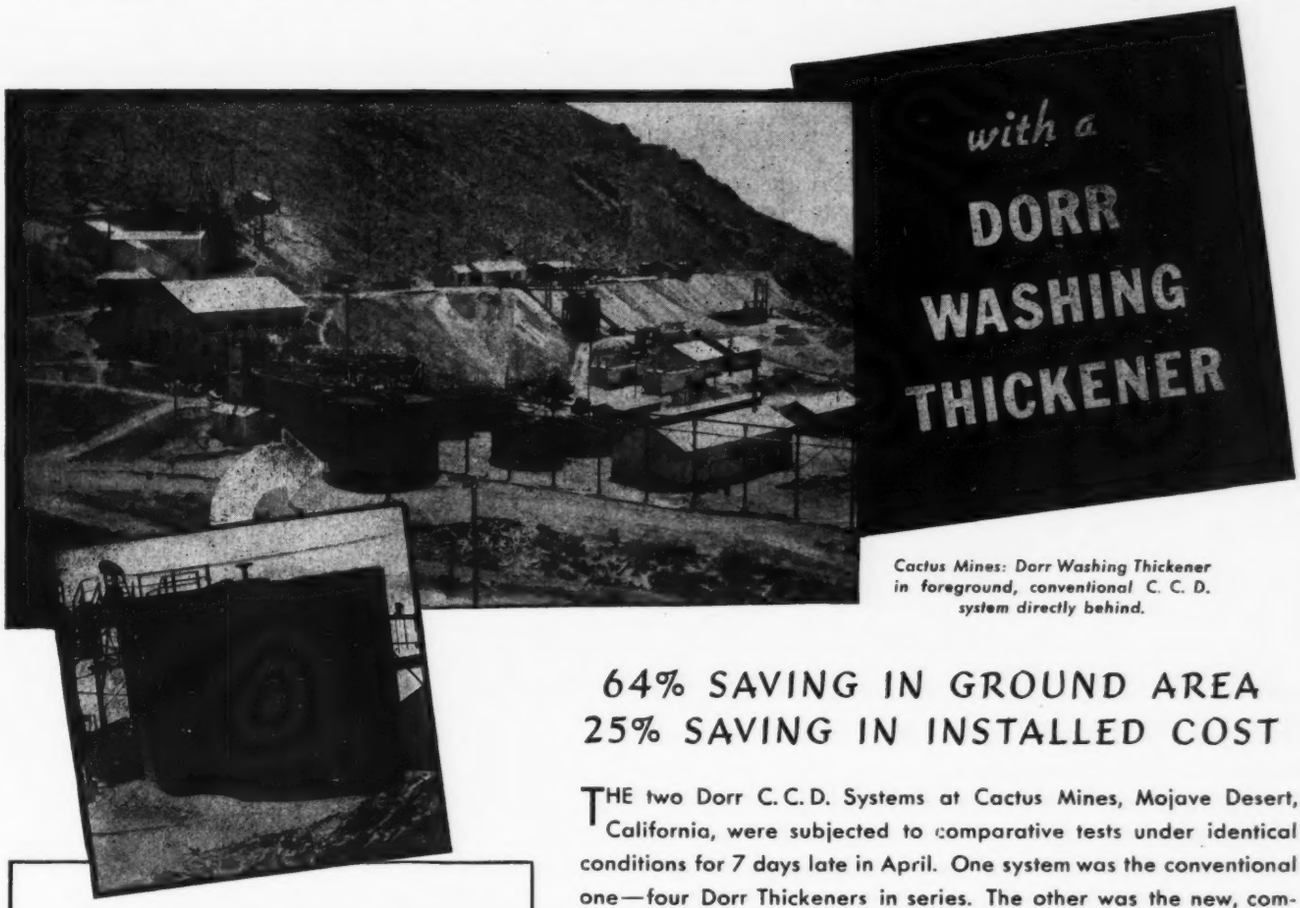
Smelter at Tooele Suspends Operations

Work expected to be resumed in August—Low metal prices bring wage cuts and mine and union officials settle "unauthorized" strike—Utah Copper plans resumption of operation August 1

▶ Shutdowns, dividend reductions, and wage cuts buffeted the Utah non-ferrous mining and smelting industry during the last month to an extent not experienced since the last depression. Some observers hope that the drastic remedies applied may enable mines, mills, and smelters to resume earlier than had production been poured into an already inert metal market. Hard upon the announcement of the shutdown of the Silver King Coalition Mines, the Park Utah Consolidated, and the Utah Copper, came the news that operations would be stopped on July 1 at the Utah Apex and Utah Delaware of the National Tunnel & Mines Company; at the Honerine, Blue Stone and Calumet mines of the Combined Metals Reduction Company; and at the Tooele smelter of the International Smelting Company. Cessation of activity at the last-named plant was accompanied by the explanation that the shutdown would be for a 45-day period. The mill is to be operated ten days a month. Ore is to be stockpiled. It is thought possible that operations can be resumed with one blast furnace on a full-time basis by Aug. 15.

▶ In line with the trend at Butte, Mont., and other camps, Utah mines and smelters reduced scale wages by 25c a day, effective at most properties June 16. Under the new scale, machine miners will be paid $5 daily, muckers, $4.50, and smelter men or common laborers, $4.

WITHIN ½% OF STANDARD C.C.D. EFFICIENCIES



Cactus Mines: Dorr Washing Thickener in foreground, conventional C. C. D. system directly behind.

COMPARATIVE OPERATIONS AT CACTUS MINES
APRIL 24-30 INCLUSIVE, 1938

		4 Thickeners Dorr C. C. D. Plant	4 Comp. Dorr Washing Thickener
Proportion Total Mill Capacity—per cent		40	60
Thickener and Compartment Over-flows —ozs. gold/T	(1)	.0344	.034
" "	(2)	.0147	.0146
" "	(3)	.0084	.0077
" "	(4)	.0033	.0036
Final Thickener and Final Compartment Discharges—Solids . ozs. gold/T		.0196	.020
Solution "		.0037	.0046
Per cent Solids . .		44.24	45.66
Washing Efficiency—Gold-per cent		96.6	96.1

DORRCO

Write for our bulletin, "The Dorr Washing Thickener," showing how the new unit is adapted to conditions at small and moderate sized cyanide plants.

64% SAVING IN GROUND AREA
25% SAVING IN INSTALLED COST

THE two Dorr C. C. D. Systems at Cactus Mines, Mojave Desert, California, were subjected to comparative tests under identical conditions for 7 days late in April. One system was the conventional one—four Dorr Thickeners in series. The other was the new, compact method—a single, four-compartment Dorr Washing Thickener.

Both systems operated on identical feeds—tailings from the same flotation cells, cyanided in the same Agitators. Feed and barren solution wash were split between the two systems, in proportion to the rated capacities of each.

The Dorr Washing Thickener gave a washing efficiency of 96.1%, the straight Dorr C. C. D. plant, with repulping between thickeners, a washing efficiency of 96.6%. As shown in the accompanying table, the conditions throughout the two systems were almost identical.

The Dorr Washing Thickener—a complete C. C. D. plant in a single unit—surpasses the straight Dorr C. C. D. on a number of points. It occupies only 35.6% of the C. C. D.'s ground area, per unit of capacity; costs, installed, 25% less; and requires only one tank, one drive unit and one sludge pump against the other's four. If both were installed indoors, as customary, corresponding savings would have been made in building cost and plant heating.

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▶UTAH

▶Protesting the wage cut, employees of the Park City Consolidated Mining Company totaling 135 and of the Silver King Coalitions Mines, sixteen of whom were retained to continue the sinking of the new shaft, were barred from the properties by pickets. For a day or two, it looked as if miners would not even be admitted to man the pumps. But quick action on the part of Chairman W. M. Kneer of the State Industrial Commission, mining officials, and officers of the Park City Local 99, International Union of Mine, Mill and Smelter Workers, resulted in a settlement of the "unauthorized" and spontaneous strike. Members voted to withdraw pickets if the men, who refused to pass the picket line, were reinstated without penalty. The wage reduction was accepted under protest. Mine operators agreed to restore wages to their old levels when metal prices improved.

▶Tintic Standard Mining Company on June 30 paid a dividend of 5c a share, totaling $57,665.75 and increasing the grand total to $17,435,106.81. Twenty-five continuous service rewards were presented to employees with records of ten and of fifteen years' service by James W. Wade, general manager.

▶Announcement was made on June 30 that Utah Copper Company will resume operations Aug. 1, providing conditions continue favorable at that time.

ARIZONA

Tennessee-Schuykill Mill Takes Custom Ore

Small producers near Chloride aided in disposing of their production—Comstock-Dexter Mines start new flotation plant

▶The Tennessee-Schuykill mill, at Chloride, has been opened to the treatment of custom ores. This action was taken to assist a number of small producing properties which would necessarily lie idle if they could not receive a local treatment for their ores. The Tennessee company has plenty of ore of its own, but is offering the use of its facilities in the interest of small mine owners.

▶American Smelting & Refining Company has 35 men employed preparatory to further development of the old Trench silver-lead mine, near Patagonia. The company is installing a power plant, change room, and blacksmith shop. The property was operated in 1936 by the Gold Canyon Mining Company and is owned by M. A. Hogan, Richard Farrell, and James McDonald, of Tucson.

▶The new 100-ton flotation plant of the Comstock-Dexter Mines, Inc., started June 1 and is now in steady production. About 34 men are employed, working in two 8-hour shifts. The new flotation plant is thoroughly modern and the diesel power plant has been enlarged to 540 hp. T. F. M. Fitzgerald is president and general manager, Hillside, Ariz. The mine has been operating steadily since October, 1935.

▶Dan Main and Howard Mottier, of Globe, have contracted to ship 50 tons of fluxing ore daily to the International Smelter at Miami. The ore comes from the Blue Bird mine, on Camp Creek north of Phoenix. A headframe and ore bins are now under construction.

▶John Gross, of Mineral Park, Mohave County, owner of the Golden Eagle mine, has leased the property to Archie Levy and associates, of Chloride. A small force of men is now at work.

▶The old Sunshine mine, in the Papago district near Tucson, is producing about 700 tons monthly of lead and silver ores. S. E. Western and associates have the property under lease and are working a small force of men in open stopes near the surface before seeking the lower levels.

▶Arizona-California Exploration Company, Ross Barclay, of Chloride, superintendent, is working ten men on the Pope mine, 20 miles north of Chloride, in the Weaver district. The property consists of five claims, and development is reported to be disclosing the ore-shoot with increasing size.

▶Thomas Turner and A. S. Johnson are superintending operations at the Money Metal mine of the Yavapai Gold & Silver Mining Company in the Big Bug district near Prescott. They plan to sink the shaft from the 400 to the 600 level, where drifting will be started.

▶Robert Farmer, operating the Big Johnnie mine, in the Papago district near Tucson, is producing about 50 tons per month. Values are in gold and silver. The shaft is now down to 150 ft. The mine is owned by Peter Ross, of Tucson.

▶The Haggerman shaft on the old Keystone mine, near Dragoon, is being sunk to lower levels. It is now at a depth of 635 ft. The work is being done by the Keystone Copper Mining Company, with C. C. Miller in charge of operations.

▶The Nance Hill property, situated in the Union Pass country near the old Frisco mine, in Mohave County, has been taken over by a group of Colorado men headed by Clyde L. Starrett, district attorney at Colorado Springs, Colo. A compressor, a small hoist, and other equipment are being installed on the property. Otto Quillin, of Kingman, is in charge.

▶J. G. Moran and L. R. Stits, of Phoenix, have resumed work at the Morning Star mine, a mile east of Bellemont, in Maricopa County. The 300-ft. tunnel has been opened and the ore is being hauled by truck to the railroad. The ore is said to have an excellent fluxing content, carrying about 31 per cent lime and a good proportion of silica. A small compressor and power drills are to be installed. Water will also be drilled for, as it is now hauled from Bellemont.

▶Ira Celum, of Clint, Texas, and Gilbert C. Priest, of Searchlight, Nev., have recently purchased equipment which they will place on a tungsten property which they have leased near Dragoon. The property is owned by A. H. Yeagley, of Dragoon.

▶The new 75-ton mill of the Santa Maria Mining Company, at Congress Junction, is completed. The present plant will be enlarged later if ore developments continue as auspiciously as at present. J. Ben Ross, of 845 North Fourth Ave., Phoenix, is vice-president and general manager of the company. B. A. Slater is superintending operations at the mine and Fred Marsten is in charge of mill work. About 40 men are employed.

▶Malco Mining Company is cleaning out the old shaft on the O. K. property in Gold Basin, Mohave County. Dan Harper is directing the operations. The property is owned by Ernest and William B. Malouf, of Los Angeles.

▶Sam Hensley started his small mill June 17 on the Jupiter group of claims in the Chimehuevis district 60 miles south of Kingman. A jaw crusher, Straub ball mill, amalgamating plates, a Wilfley concentrator, and a Denver flotation unit are installed. Ores shipped from the property have heretofore given satisfactory returns. Sufficient ore is in sight, it is claimed, to operate the mill continuously for the next two years. The Jupiter group is situated southwest of the old Klampf property, formerly operated by the Greenway interests of Arizona.

NEVADA

Arizona Comstock Plans Larger Flotation Plant

Company seeks permission to reorganize and obtain funds for expanded operations —Consolidated Coppermines maintains production around 6,000 tons of ore daily

▶A petition has been filed in the Federal District Court at Carson City by the Arizona Comstock Corporation, seeking permission to reorganize under Sec. 77b of the Federal bankruptcy laws. Stockholders and creditors are cooperating in the plan, which, it was indicated, will be given approval at a called meeting to be held on July 11. Assets enumerated in the petition include underground ore variously estimated at 1,000,000 to 1,500,000 tons, of value ranging from $8 to $10.50 per ton, 440,000 tons of ore available for mining by shovel in the outcrop of the Comstock lode, and 250,000 tons of impounded tailings with gold-silver content of a little over $2.10 per ton. It is the purpose, with promised new financing completed, to enlarge the present 400-ton flotation mill and partly constructed cyanide plant to treat a minimum of 500 tons per day. W. J. Loring is president and managing director at Virginia City.

▶Nevada Consolidated Copper Corporation closed down its huge pit mine at

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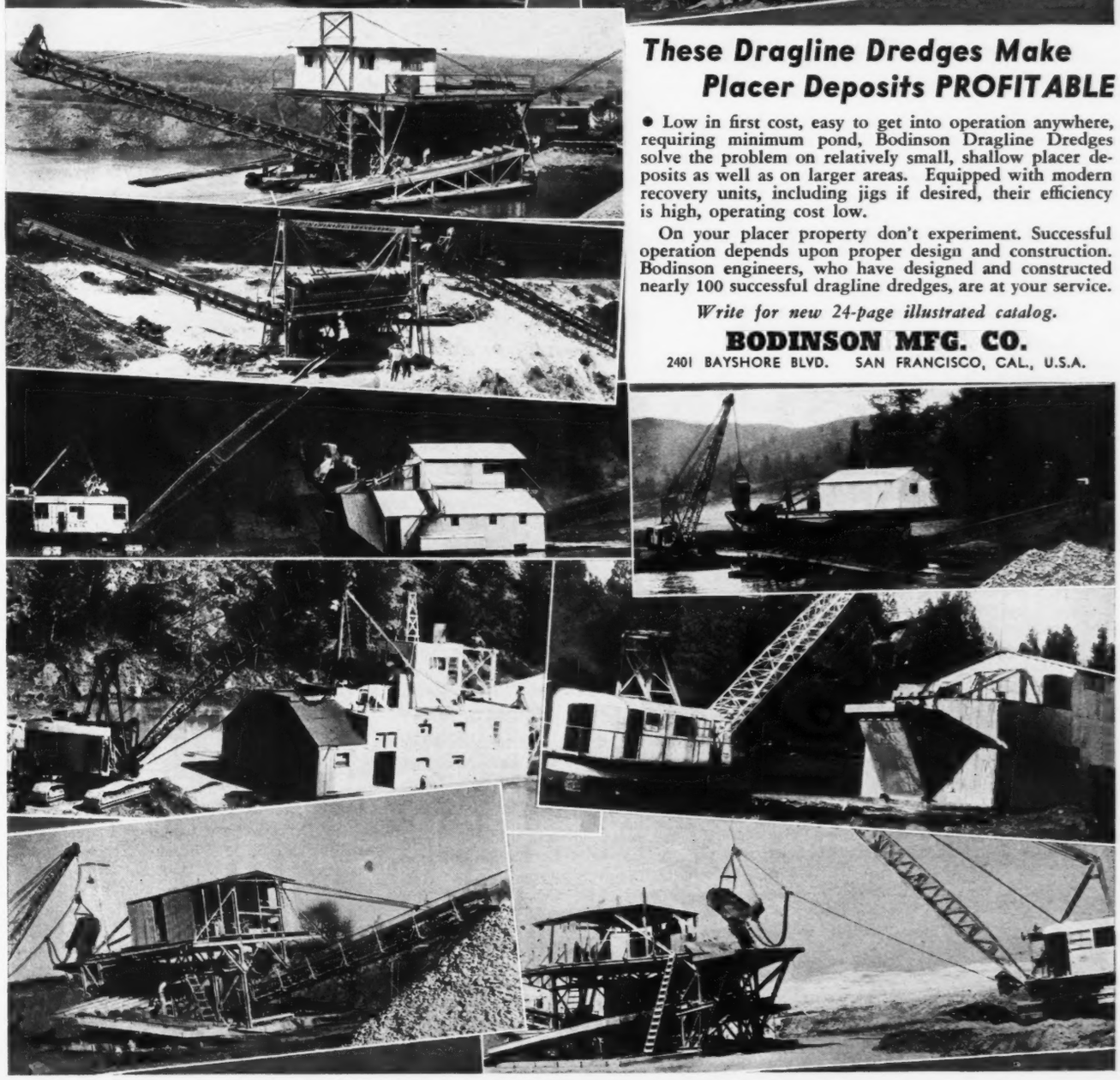


▶NEVADA

Ruth and its smelter and concentrator at McGill on June 16 for a period of 30 to 45 days, but the flotation mill will continue to treat around 6,000 tons of copper ore per day from the Kimberly property of the Consolidated Coppermines Corporation, the latter having notified the Nevada Consolidated that it would not close down, as earlier announced. This decision was reached at a recent meeting of Coppermines directors in New York, attended by J. B. Haffner, manager at Kimberly.

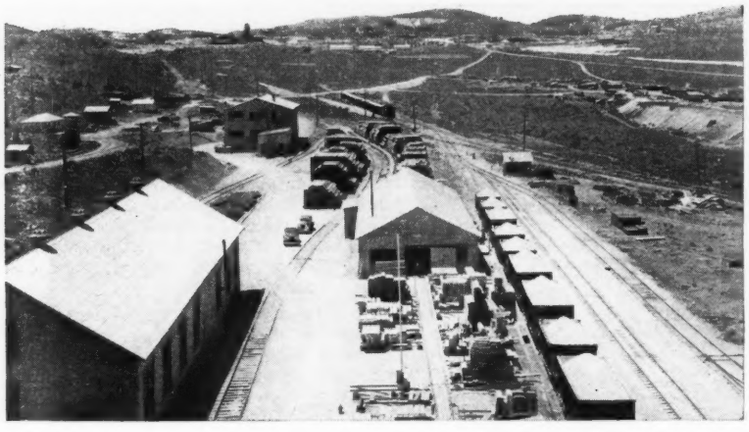
▶ Production in May from the flotation mill of the Sierra Nevada, Ltd., on Cedar Hill, at the north end of the Comstock lode, was 6,800 tons, with gross recovery of approximately $18,000, according to Arthur Thomas, president, with offices in the Lyon building at Reno. Ore is mined from the surface by power shovel after removal of nearly 100 ft. of overburden.

▶ Cyanide equipment has replaced flotation in the 100-ton mill on the Overland mine of the Storey County Mines Company, near Silver City in the Comstock district. The company lately acquired properties adjoining its Overland mine, including the Lager Beer and Flora Temple, early-day producers of rich ore, and is extending development work on deeper levels. Clyde E. Collins is manager.

▶ High grade gold-silver ore has been opened by a short drift south from a raise above the 800-ft. level of the Tonopah Divide mine, 5 miles south of Tonopah, in Esmeralda County. A 50-ton carload, shipped to a Utah smelter, gave returns of 1.60 oz. gold and 26.82 oz. silver per ton. E. J. Erickson is manager.

▶ Acting reputedly for a group of Texas oil men, F. J. Sur has obtained an option on the old Nevada Wonder silver-gold mine, in Churchill County, from L. F. Curtis, mine equipment dealer of Reno. The mine, once a noteworthy producer, has been worked in late years by lessees, with some production of smelting ore.

▶ Articles of incorporation of The Raskob Mining Interests, Inc., have been filed with the Secretaries of State of Nevada and California. Incorporators are Aquin P. Feeney, J. C. Barton, and R. P. Raskob, all of Reno. John J. Raskob, Jr., and Robert P. Raskob, sons of the retired automobile and airplane manufacturer, maintain Reno offices and an engineering staff, of which Feeney and Barton are members. The Raskob organization has lately taken under option a silver-lead-gold property near Wellington, in Douglas County.



Surface buildings at the Emma-Nevada shaft of the Consolidated Coppermines, in Nevada, where production of copper continues on a curtailed basis. The town of Kimberly lies in the background and the Morris Brooks shafts on the left

▶ One of two 14x14-ft. Door filters recently delivered at the 600-ton mill of the Getchell Mine, Inc., in eastern Humboldt County, is in use, and the plant, employing cyanidation of oxidized ore and a preliminary roast of sulphide ore, has been treating up to 540 tons per day. Capacity mill feed will be attained with the installation of the third filter unit, it was indicated by N. H. Getchell, vice-president and manager.

▶ Addition of a tube mill and other minor units has increased the capacity of the mill of the South Comstock Mines, Inc., at Silver City, from 40 to 75 tons. A larger primary crusher, ordered and soon to be installed, will raise capacity to 100 tons per day. Equipment includes flotation cells and jig-type amalgamator. The company has acquired adjoining claims of the Esher Mines Company. C. D. Terwilliger, of Reno, is president and Ernest W. Harker, manager.

▶ Operating the old Silver Connor mine, near Eureka, John S. Bagg has been shipping a substantial volume of ore to the McGill smelter of the Nevada Consolidated Copper Corporation and has provided a 25-ton diesel truck and trailer to deliver his product to loading bins at the Ruby Hill rail spur.

▶ With the purpose of acquiring and reopening the old Clay Peters gold mine, 12 miles northeast of Mina, in Mineral County, the Clay Peters Syndicate has been formed by a group of Utah and Nevada men identified with major operations in the Pioche district, and equipment has been provided at the 240-ft. main shaft. The group heading the project was said to include J. H. Buehler, Paul Gemmill, Guy Snyder, A. J. Bettles, T. J. Sims, and Carl Spencer.

▶ A body of high-grade gold ore is reported to have been opened on the 100-ft. level of the new main shaft of the Haystack mine of the Jungo Star Gold Mines Company, in northern Pershing county. Several carload smelter shipments have been made lately by lessees sinking the shaft under contract. C. D. Terwilliger, of Reno, is president and R. V. Taylor is in charge, receiving mail at Jungo. E. W. Harker is directing engineer.

▶ Ore exposed on the newly opened 600-ft. level of the Penelas gold mine, in northern Nye County, is wider and of better grade than any found elsewhere in the series of fissures in andesite, according to a report by L. D. Gordon, president of the Penelas Mining Company and in active charge. The 50-ton cyanide mill has run without interruption since its completion early in 1936. The company's main office is at Fallon, Nev.

▶ The mill at the Jumbo mine, in the Awakening district, in Humboldt County, has resumed treating around 40 tons of gold ore per day, and 35 men are employed under the direction of J. Schilling, superintendent. The mine was acquired early last year from George B. Austin by J. K. Wadley and H. L. Hunt, wealthy Texas oil operators, under a 30-year, $10,000,000 option of purchase. Development of the Jumbo mine is still of limited extent, through several tunnels gaining maximum depth of less than 300 ft.

▶ Tailing dumps from long-dismantled amalgamating mills at the Mayflower and Pioneer gold mines, in the Pioneer district, Nye County, are to be treated in cyanide leaching plants now near completion. The dumps have been leased on a royalty basis from A. L. Lidwell, of Springdale, by S. Bacon, who is building the plants and has offices at Beatty, Nev.

▶ Claims in the Cimarron district, 29 miles north of Tonopah, in Nye County, where high-grade gold ore was exposed recently by the owner, E. M. Booth, of Tonopah, have been acquired under option by Fred A. Vollmar, Jr., who is associated with E. L. Cord in the operation of mines and two mills at Silver Peak, Esmeralda County. Mine equipment has been provided and Mr. Booth is in charge. Louis P. Bartholomees, formerly with the South American Development Company at Guayaquil, Ecuador, lately examined the Cimarron claims, an option on which was relinquished some two months ago by the Tonopah Mining Company of Nevada.

MONTANA

Gold Placer Operations Get Under Way

Active season anticipated—Base-metal production continues quiet and several small mines are closed, but producers are heartened by better metal markets

▶Mining activities in Montana appear to be near an all-time low. With the drastic reductions in copper production at Butte, it is significant to note that virtually all small-tonnage base-metal producers outside of Butte have closed down. The only important unit of this class still in operation is the Comet mine of the Basin Montana Tunnel Company, which, according to a recent stockholders' report, has a very limited resource under existing metal prices. All zinc producers at Philipsburg and lead operators at Hughesville, except a few high-grade small-tonnage units, have closed down.

▶Also, under the present limited rate of operation of the Washoe plant of the Anaconda Copper Mining Company, a number of small shippers of siliceous gold ore are unable to market their production. Currently, however, basic gold ores are still being received at the East Helena plant of the American Smelting & Refining Company. There is a growing fear in all districts producing high-grade crude ores or concentrates requiring additional custom refining that, unless conditions improve generally, they may not be able to market their products. Recently, the Federal Mining & Smelting Company announced the closing of its Morning mine, in Idaho, which is the chief normal supply of lead ores to the East Helena plant. Reflecting better sentiment in business later in the year, producers were encouraged by the recent improvement in lead, zinc and copper prices.

▶ Only those operations capable of producing a product marketable direct to the United States mint seem to be free from uncertainty. This group includes both placer gold deposits and gold properties equipped with cyanidation or amalgamation plants. Though a large number of such plants are in service in the State at this time, it is a safe prediction that renewed activity in construction or conversion to plants of this type will be forthcoming in the next few months. At present, the Porter brothers and the Winston brothers, both operating dredges in the Helena area, are the largest placer gold producers. Some of the most important cyanide plants include those at the Ruby Gulch and the Little Ben Mines, in the Little Rocky district, and the Ermont, Butte Highlands, and Broadway mines.

▶ Anaconda Copper Mining Company has announced a 50c reduction in its wage scale, effective June 20. Salaried employees in brackets above and inclusive of $1,800 a year were reduced 10 per cent effective June 1.

THE *Dredgeman's* *Notebook*

★ **MOVING DAY**

(Above) Dismantling 8½ cu. ft. gold dredge on shelf in pond prepared by dredge before pond level was lowered.

(Right) Reassembling same gold dredge after being reconditioned and altered to suit requirements of new fields.

BUILT originally in 1905, this Yuba dredge already has operated successfully in two California gold fields. Now, using much of the original machinery it will soon go to work on a third deposit—more proof of long life of Yuba equipment—more proof of Yuba experience rebuilding for profitable operation.

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1905 This dredge with wood hull and 7½ cu. ft. buckets digging 61½ ft. below water level was built and used at Hammonton.

1914 Wood hull was replaced by steel hull and superstructure using original machinery. Dredge operated until available ground was exhausted.

1927 Steel hull and machinery reconditioned, moved to Folsom field and adapted to 8½ cu. ft. buckets digging 46 ft. below water level.

1938 Complete dredge again moved—to Oroville field.

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NEWS FROM Washington

By Special Correspondent

CONGRESS has adjourned, leaving a record of major legislation rarely equaled and a record of appropriations never equaled in peace time. By persistence, with the aid of billions which could be used for vote influence, the President achieved a large majority of the major legislative aims which he sought. He was defeated by Congress in important matters only three times, an amazingly small number in view of the tremendous scope of legislation undertaken. The defeats were:

1. Reorganization of the executive departments and independent establishments was not authorized. Nor were the new rights of regulating Civil Service and audit approved.

2. The tax bill as enacted went directly contrary to the President's desires for retention of undistributed profits taxes and the burdening of capital gains.

3. Enlargement of the Supreme Court was denied by Congress in its earlier session; but much of the liberalizing of court decisions sought by the President has been accomplished partly by the naming of the new Justice and, more largely, by persuasion of the Court that new liberal laws being formulated reflect the will of the majority of the people and, therefore, should be acceptable when carefully drafted by Congress.

Bills Congress Passed

Wage-Hour—A compromise law, with somewhat flexible provisions, aims at establishing a national standard of a 40c minimum wage and a 40-hour maximum week in seven years; but there are numerous exceptions, which may either delay or accelerate reaching of standards fixed.

Anti-Trust—Eventual revision of anti-trust laws is the object of an inquiry to be conducted at the President's suggestion and under his direction by a national economic committee composed of three Senators, three Representatives, and six officials named from the Departments of Justice, Treasury, Commerce, and Labor, Securities and Exchange Commission, and Federal Trade Commission.

Federal Trade Commission—Wheeler-Lea amendment to FTC law extends the Commission's jurisdiction to include deceptive practices on any goods, with specific provision imposing criminal penalties for false advertising of food, drugs, cosmetics, and health devices.

Taxes—The bill, departing from President's recommendations, greatly modifies the undistributed profits tax on corporations and establishes flat capital gains taxation. It became law May 28 without the President's signature.

Relief—A three billion to four billion dollar spend-lend bill includes $1,425,000,000 for relief and work relief, $965,000,000 for public works, $300,000,000 for public low-cost housing, $212,000,000 for parity-price benefits to farmers, $100,000,000 for rural electrification.

Natural Gas—Federal Power Commission is given control over transportation and sale of natural gas in interstate commerce similar to that over electric power granted by Public Utility Holding Company Act of 1935. This law is a long step toward Federal regulation of a natural-resource industry.

Bankruptcy—Chandler bill embodies first general revision of bankruptcy act in nearly 50 years. Designed to increase efficiency and speed up administration.

Loans to Business—RFC act amended to authorize loans to private business concerns and public bodies on more liberal terms than before.

Munitions—Secretary of War authorized to distribute "educational orders" totaling $2,000,000 a year for five years for munitions of special design in order to familiarize private firms with their manufacture.

Stream Pollution—Public Health Service directed to study pollution conditions, cooperate with States in abatement, and make loans and grants for construction of control works. Law authorizes no compulsion. (This bill was vetoed by President Roosevelt on June 27.)

Housing—U. S. Housing Authority Act amended to increase maximum loan limit of USHA for public slum-clearance projects from $500,000,000 to $800,000,000. National Housing Act amended to liberalize Federal Housing Administration mortgage insurance system to stimulate private residential building. Down payment reduced to 10 per cent on houses costing $6,000 or less; insurance extended to new classes of multi-family projects.

Phosphate Inquiry—A joint Congressional committee is established to study the nation's phosphate resources and to prepare recommendations for Federal supervision of this mineral industry, under the guise of protecting the nation against shortage.

Phosphate Policy

CONGRESS, at the very end of the last session, carried out the President's suggestion and named the Congressional committee of three Senators and three Representatives to investigate American phosphate resources and their development. The nominal objective is the formulation of a policy by which Congress may be guided next year in regulating the mining of phosphate rock and the manufacture of phosphate products for American fertilizers and for export.

A secondary objective, dominant with some of the committee members, is the hope that Western phosphate development may facilitate early application of power surplus at some of the Western hydro-electric projects which are nearing completion in the Intermountain country. Less emphasized is the hope of Chairman James P. Pope, Senator from Idaho, that attention to Western phosphate matters may be regarded by the voters of his State as another good reason for returning him to the Senate for another six years. Senator Pope is chairman of the joint committee.

The limited appropriation for the work of the Committee, $10,000, indicates clearly that travel, hearings, and conferences will consume all of the funds. The work of the Committee was initiated immediately following the adjournment of Congress by the calling of Secretary Wallace to explain the importance of phosphate, and Chairman H. A. Morgan of T.V.A. to expound development possibilities. Representatives of the two agencies headed by these officials are expected to do the technical work for the Committee. Further hearings are expected to be held, beginning in Pocatello, Idaho, about July 15. Membership of the committee is Senators Pope (Idaho), Pepper (Florida), Norris (Nebraska), and Representatives Leavy, (Washington), Peterson (Florida), and Case (South Dakota).

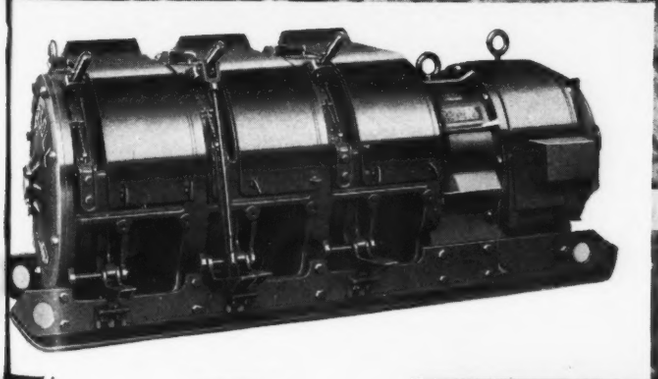
Wage-Hour Law

THE FEDERAL GOVERNMENT embarks on a new program of regulating hours and wages by Congressional statute with the enactment of the wage-hour bill on June 14. The objective is to forbid transportation or handling in interstate commerce of any goods produced or handled by employees whose wages and working hours do not conform with the applicable requirements of this law. The ultimate objective is to fix 40c per hour as the minimum wage and 40 hours per week as the maximum working period. Initially, however, 25c per hour and as much as 44 hours per week will be permitted from the effective date in October.

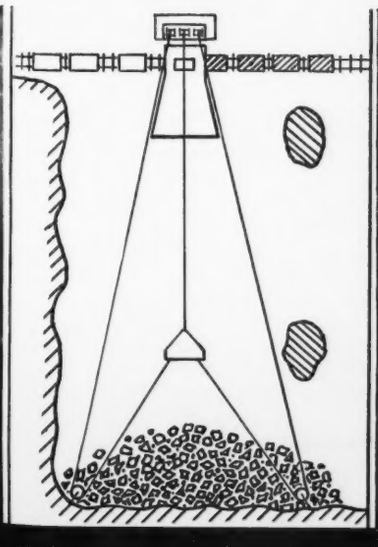
Administration of the multitude of technical provisions of the law will be cared for by an administrator to be named by the President as the head of a newly established wage and hour division of the Department of Labor. The administrator will work both through a staff of employees and through industry committees to which he is required to refer questions as to wage rates and working hours. Recommendations of such committees are intended to provide reasonable classifications and a basis for such exemptions from the law as may be permitted.

Under normal conditions, 25c and 44 hours will apply as limits for one year. Then 30c and 42 hours will apply for six years, and the 40-40 standard becomes mandatory after seven years. However, the administrator may speed up, as well as delay, the application of both standards. Hence in many cases

I-R Three-Drum "Tugger" Hoists Are Steadily Reducing Loading Costs



View of three-drum "Unit-Assembly" Tugger Hoist showing the controls.



A three-drum "Unit-Assembly" Tugger Hoist mounted on a wooden semi-portable ramp and pulling 48" scraper. In wide stopes or workings, I-R three-drum hoists have reduced loading costs as much as 50%.

The I-R "Unit-Assembly" design, first introduced in double-drum sizes, has pronounced advantages in three-drum hoists.

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it would be possible for the 40-40 standard to be fixed almost at once after the beginning of operations under the law this fall.

Only a portion of the special exemptions for averaging hours which have been sought on behalf of the mining industry were granted. It is expected, however, that many amendments to the law will be required during the next year or two and that any valid objections of industry to the absolute limits first provided can be met if the general spirit of limiting working time is complied with.

International Minerals

NOMINALLY, the proposed mineral stockpile legislation (S. 4012) was killed by action of the Budget Bureau recommending against the required appropriation. Actually, however, it does not appear that any sudden economy spirit to save a few million dollars was the real reason for defeat of this bill, which for the first time formulated accurately the recommendations of a group of the executive departments. (See *E.&M.J.*, June, p. 68.)

Interest in this subject has not been abandoned and a special joint Congressional committee has already begun to consider ways and means for handling the matter next year. This committee is made up of three representatives from the appropriations subcommittees of each house of Congress, with Reperesentative Scrugham, of Nevada, as chairman. In its initial action, this committee evidences a desire to have the mineral stockpiles built up from domestic ores. This has led to the criticism on the part of some that politics, rather than preparedness, is going to govern action.

The failure of appropriation for stockpiles also involved defeat of the proposal that the Bureau of Mines and the Geological Survey should have special funds for additional investigations of these minerals. Also lost were all of the various proposed bills which planned limits on the export of scrap metals. Most of the measures never got beyond reference to Congressional committees.

The considerable delay which has occurred in the formulation and promulgation of the trade agreements with Great Britain and Canada has given certain mineral interests of Washington the jitters. Matters of this character are handled with the utmost secrecy in the Department of State and by its technical advisers in other departments. There is no reason to believe, however, that the mineral industries are going to suffer more from these particular negotiations than in any previous treaties.

Anti-Trust Inquiry

A COMMISSION of six members of Congress and six representatives from the executive departments will carry out a study of monopolistic practices and required legislation with a view to recommending a revision of the anti-trust laws next winter. From the Congressional membership of the Committee it is evident that a serious study is contemplated, not merely a series of corporation-baiting and headline-seeking hearings. Senatorial members are O'Mahoney, of Wyoming, chairman; King, of Utah; and Borah, of Idaho. From the House of Representatives the members are Sumners, of Texas; Eicher, of Iowa; and Reece, of Tennessee. The departmental members of the commission will come one each from Treasury, Justice, Labor, Commerce, Federal Trade, and S.E.C.

Since the naming of Thurman Arnold as chief of the anti-trust division of the Department of Justice, there has been a significant change in the anti-monopoly methods and plans in Washington. More and more Mr. Arnold seems to be injecting the idea that bigness is not necessarily badness; but bigness must justify itself by proving greater efficiency. This philosophy leads, almost inevitably, to the conclusion that some tax on bigness to equalize the opportunity between large and small enterprise is likely to be urged in Congress next winter. This idea follows very clearly the President's personal view (which differs radically from that of most economists) that bigness implies for corporations an ability to pay, just as big incomes of individuals are supposed to do.

News "Fines"

Soviet Minerals have suffered materially during the past year as an incident to the breakdown of much of the industrial effort of U.S.S.R. An up-to-date résumé of the problems and the statistical results of 1937 operation has been issued by the Bureau of Mines as its second Foreign Minerals Quarterly, dated June.

Forward Buying—Washington would like to believe that application of the new wage-hour law is going to stimulate buying for future deliveries by industry. Low present goods inventories, both in the hands of producers and consumers, afford some basis for a spurt if improved business is expected. The Government itself is taking steps to buy now, for its own use, for redistribution as relief, and for surplus controls through FSCC. The effort is to buy manufactured goods through customary trade channels as much as possible, in order to avoid upsets in normal business relations.

Manganese Alloys—Pure manganese made by electrometallurgical methods can probably not compete on a price basis with ferromanganese for use in the steel industry. Even the most optimistic estimates of the Government investigators indicate that other applications of this metal are more promising. Substitution of manganese for nickel is being investigated, particularly this usage in non-ferrous alloys.

War in Europe—Drought, which is limiting Mid-continent crops of Europe, makes warlike gestures of dictators much less likely this year. Department of Agriculture officials hope also that these European food shortages may give at least a distress market for the huge wheat surpluses now in prospect. Such new trade would greatly improve agricultural buying power with a minimum of Federal price-pegging and "parity" bonus.

Metals Laboratory — Congress decided to earmark $300,000 of the relief funds for the building of the precious and non-ferrous metals station of the Bureau of Mines at Salt Lake City. It is expected that final plans will be completed and the contract let as early in the summer as the carrying out of administrative routine will permit. No immediate change in the Western investigations of the Bureau is contemplated. But when the new station is completed it is hoped that several of these projects can be substantially enlarged in scope and speeded up.

Railroad Buying—Loans by RFC on an "easy-money" basis were not authorized by Congress. This reduces the likelihood of equipment buying and major improvements by weak roads. But, as one Washington cynic says, Congress at least modernized the bankruptcy laws, so that should help the weak railroads some. Seriously, Washington expects some new bankruptcies among big carriers. It also wonders whether labor did not make a bad tactical error in blocking Federal relief efforts.

Budget—It is hard for Washington observers to recall just what was going to be the approach to balance in the Federal budget during the fiscal year which began July 1. Actual appropriations in the last session exceeded $10,000,000,000, and an all-peace-time record for deficit is now confidently predicted.

Real Competition — Washington spokesmen of the mining industry are emphasizing the necessity for modernization of coal mining in order to defeat inroads of natural gas and petroleum on solid fuel markets. Monopoly investigators seldom take account of this *inter-commodity* competition which hits copper and aluminum, alloy steel and carbon steel, and a flock of other mineral and metal products more than the *inter-company* competition about which anti-monopolists so vigorously orate.

Bills That Failed

FEW OF THE MEASURES that failed of enactment were of direct concern to the mining industry. Most important of these few were those intended to control exports of scrap metals, and the one contemplating building a stockpile of strategic metals and minerals by the War and Navy Departments. Congress debated at great length numerous labor-aiding measures other than the wage-hour bill. But only the enlarged Walsh-Healey Act got far enough to be significant. That scheme for making wage-hour standards applicable to many more supplies and services purchased by the Federal Government failed largely because of the drastic extension which its proponents insisted on. The same idea will arise again next year. Also, many amendments to the National Labor Relations Act are merely postponed, not dead. Aid for the railroads, Federal licensing of corporations, varied patent and trade-mark bills, chain-store taxation, regulation of bank holding companies, and a variety of planning and economic control bills will gather dust until the next Congress discusses the general sentiment of the voters.

President Roosevelt Signs Assessment Bill

▶ On June 29 President Roosevelt signed the bill granting suspension of annual assessment work on mining claims held by location in the United States and Alaska during the year July 1, 1937, to July 1, 1938. The bill is as follows:

Be it enacted, etc. That the provision of section 2324 of the Revised Statutes of the United States, which requires on each mining claim located, and until a patent has been issued therefor, not less than $100 worth of labor to be performed or improvements aggregating such amount to be made each year, be, and the same is hereby, suspended as to all mining claims in the United States, including the Territory of Alaska, during the year beginning at 12 o'clock m. July 1, 1937, and ending at 12 o'clock m. July 1, 1938: *Provided,* That the provisions of this act shall not apply to the case of any claimant not entitled to exemption from the payment of a Federal income tax for the taxable year 1937: *Provided further,* That every claimant of any such mining claim, in order to obtain the benefits of this act, shall file, or cause to be filed, in the office where the location notice or certificate is recorded, on or before 12 o'clock m. July 1, 1938, a notice of his desire to hold said mining claim under this act, which notice shall state that the claimant, or claimants, were entitled to exemption from the payment of a Federal income tax for the taxable year 1937: *Provided further,* That such suspension of assessment work shall not apply to more than 6 lode-mining claims held by the same person, nor to more than 12 lode-mining claims held by the same partnership, association, or corporation: *And provided further,* That such suspension of assessment work shall not apply to more than 6 placer-mining claims not to exceed 120 acres (in all) held by the same person, nor to more than 12 placer-mining claims not to exceed 240 acres (in all) held by the same partnership, association, or corporation.

Recent Labor Angles in the Non-ferrous Metal-mining Industry

June 9, 1938—The National Labor Relations Board today announced dismissal of the complaint against the American Smelting & Refining Company, New York, that the company had dominated an inside union and had interfered with the self-organization of its employees at its Baltimore, Maryland, plant. Charges against the company were filed by the Copper Workers' Industrial Local Union No 398, International Union of Mine, Mill and Smelter Workers of America, affiliated with the Committee for Industrial Organization. Evidence before the Board disclosed that on June 11, 1937, following abandonment of an old employee representation plan, a group of the company's employees met secretly at the company's plant and decided to form the Copper Employees Association, Inc. The Board stated that "there is no substantial evidence to indicate that the respondent (company) sponsored, assisted, or dominated the Association," pointing to the fact that both groups solicited members on company property during working hours, that foremen had been instructed to maintain strict impartiality, that all the witnesses who were members of the industrial union testified that company officials had been friendly with them and that they had no complaint against the company other than the recognition of the Association. All witnesses admitted that numerous employees wore CIO buttons at work without ever being reprimanded.

June 18, 1938—The National Labor Relations Board today ordered Kennecott Copper Corporation and its wholly owned subsidiary, Utah Copper Company, to disestablish Employees' General Committee, Department of Mills, as representative of any employees at the companies' Arthur and Magna mills. Also, the companies were required to end efforts to interfere with organizing activities of International Union of Mine, Mill and Smelter Workers, Local 392, affiliated with the Committee for Industrial Organization. The companies must post notices at their mills that they will no longer interfere with the exercise by employees of their right to join labor organizations of their own choosing, and that the employees' committee is disestablished.

June 14, 1938—The National Labor Relations Board today announced certification of four trade unions affiliated with the American Federation of Labor as exclusive collective bargaining agencies for workers eligible for their respective crafts employed at the Phelps Dodge Corporation's United Verde Branch, at Jerome and Clarkdale, Arizona.

June 29, 1938—The National Labor Relations Board today approved a stipulation agreement settling unfair labor practice charges against Black Mammoth Consolidated Mining Company, Silver Peak, Nev., filed with the Board by International Union, Mine, Mill & Smelter Workers (CIO), and issued an order against the company based on the stipulation. Under the terms of the order, the company is required to cease and desist from engaging in unfair labor practices and to disestablish Silver Peak Mine and Mill Workers' Association, an unaffiliated labor organization, as representative of any of its employees. Notices must be posted in conspicuous places throughout the company's properties for 30 days, stating that the company will comply with the provisions of the Board's order.

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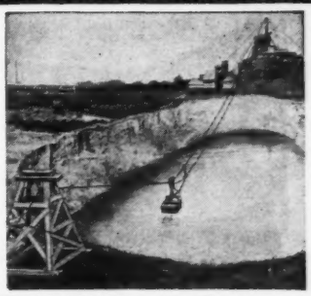

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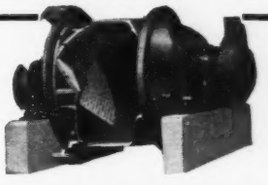

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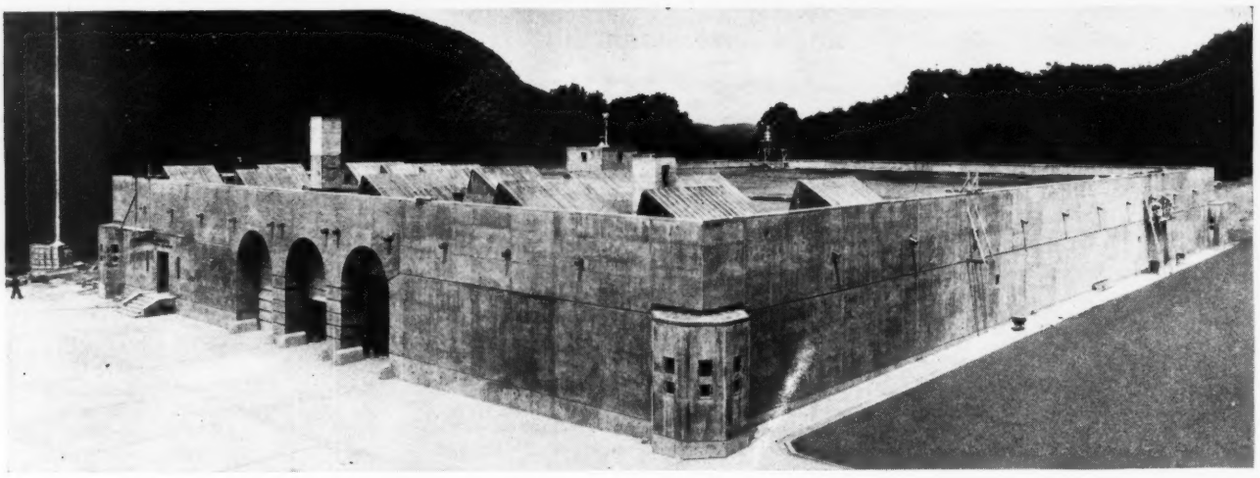

Acme

New silver depository of the United States Government near the West Point Military Academy campus, West Point, N. Y. This concrete structure provides a secure haven for about two billion dollars' worth of silver bullion that will be stored there soon

IDAHO

Exploration Continues At Morning Mine

Ore production was suspended, however, on June 25—Elk City gold district active, with many producers

▶ The Morning mine of the Federal Mining & Smelting Company, at Mullan, employing more than 600 men, closed down on June 25, according to Manager H. G. Washburn. Low metal markets are the cause for the halt in operations at the big property, long one of the Coeur d'Alene district's leading producers. During the shutdown, exploration of the possibility of finding additional orebodies will be carried on, as well as sinking below the 4,050 level of the present orebody.

▶ The Lucky Friday group of claims, in the Mullan district, was the scene of a recent strike of commercial ore, according to John Sekulic, of Mullan, and John George, of Kellogg, who hold the property under lease. The ore is galena, carrying a high silver content in a vein about 3 ft. wide. Plans are being made to sink a shaft to develop the vein.

▶ The National Labor Relations Board hearings involving the charges against the Federal Mining & Smelting Company at the Morning mine, held in Wallace, ended on June 14. Thomas S. Wilson, Portland, Ore., examiner for the Government, will make his recommendations at a later date. Leaders of the C.I.O. charged the Federal company had discriminated against union workers.

▶ Diamond-drill operations are under way at the Metropolitan Mines Corporation property, on Big Creek, from the 500-ft. level of the shaft. The stockholders have elected R. L. Brainard, of Kellogg, president; John Gleeson, of Spokane, vice-president; Roy H. Kingsbury, of Wallace, secretary-treasurer; and M. T. Miller, of Spokane, and Mrs. Mary Baumgartner, of Seattle, directors.

▶ The Penman mine, in the Orogrande district of Idaho County, idle last year, will resume production in July. A diesel compressor has been installed. Markus Lies, of Cottonwood, Idaho County, is president and C. T. Peterson, of Tacoma, Wash., is vice-president.

▶ The Coeur d'Alene Mines Corporation management plans an aggressive development campaign from the bottom of the 1,000-ft. shaft when that objective is reached in July, according to D. E. Watson, secretary. Directors have authorized the purchase of the latest type of mucking equipment.

▶ E. T. Fisher and A. F. Baumhoff, operators of several gold dredges in the Boise basin, will start operations this summer on the Little Smoky River, 17 miles from Fairfield. The dredge is of the Yuba type, equipped with 58 buckets, each having a capacity of 2½ cu. ft.

▶ The Belshazzar mine, famous old gold producer near Quartzburg, may again enter the ranks of active mines if examinations are satisfactory. Bliss Moore and associates, of Spokane, have leased the Belshazzar from the Idawa Gold Company, of which E. A. Nordquist, of Boise, is secretary-treasurer.

▶ The Elk City gold district, Idaho County, is showing more activity than in many years. Clearwater Mining Company recently constructed a modern camp, 20-ton pilot mill, and power plant. S. D. Alexander and associates are successfully operating a new $75,000, two-yard diesel dragline on the south fork of the Clearwater, above Golden. The Newsome Creek Mining Company, of California, installed a new $80,000 dredge on Newsome Creek. L. N. Ellis is superintendent. Bender Engineering Corporation recently erected a custom mill at Elk City. Mount Vernon Gold Mining Company has moved its all-steel pontoon dredge to the Little Slate Creek country. The Gold Point mine, at Red River, recently completed a mill at the mouth of Relief Creek. Bunker Hill & Sullivan recently completed a 25-ton pilot mill and is working 35 men on the Mammoth property. Elk City Gold Mining Company has erected a large modern camp and completed a new pilot mill. Shipments of high-grade ore and concentrates will be made this summer. Other activities, according to R. B. Greene, of the Elk City Gold Company, are in evidence at the Key, Tippie, and Moose Creek placers, Buffalo, Imogene, Montana, Center Star, Grangeville Gold, and Four Mile. Six dragline and dredge operations are in progress near Elk City.

COLORADO

New Mills Add To Gold Production

Operations at mines in higher altitudes increase as heavy winter snows recede—Numerous leases in scattered districts

▶ The new mill of the Clear Creek-Gilpin Mining Company at Dumont started operations around the first part of July. Mr. Hunt, former mill superintendent for the Shenandoah-Dives Mining Company at Silverton, is in charge of mill operations. Mr. Specht, of Denver, is general manager.

▶ The Calvin-Remington-European property, on Seaton Mountain, recently opened a good body of ore. H. L. Sinclair, general manager, has consolidated all of the leases, and installed greater compressor capacity. J. J. Giradet, of Idaho Springs, is engineer.

▶ The Cresson mine, at Cripple Creek, is maintaining steady production, especially from the eighteenth level, where a large body of low-grade ore is being

developed. This level is the first below the drainage tunnel, and was pumped out after being under water for a number of years. Alfred Bebee is general manager of the Carlton interests in the Cripple Creek district.

▶ The Vindicator-Cameron drive has progressed nearly 900 ft. and three small bodies of ore have been found, which will be worked later. The object of this 8x7 ft. tunnel on the 20th level is to work the lower levels of the Cameron mine. A compressor is to be installed on that level to permit operations with three shifts instead of one. The work follows the main Vindicator and Hull City fissure zones, and will run in a northwesterly direction through the Hull City, Findlay, and Shurtloff properties into the neighborhood of the South Burns shaft, where the tunnel will be turned towards the Cameron shaft. The twentieth level of the Vindicator is connected with the drainage tunnel, which eliminates pumping. The work will cut Bull Hill at the South Burns shaft at a depth of 2350 ft. below its present collar. Hoy and Todd of Buffalo, N. Y., are financing the operations, and they also direct Cameron Mines, Inc.

▶ The Golden Conqueror Company recently completed the installation of a new hoist at the South Burns shaft. Local men have leased the north 500 ft. block of the Wilson claim of the Free Coinage Company, which will work through the Hahnenkratt shaft. The lease granted is limited to a depth of 500 ft. below the surface, as the ground below this point is part of the Golden Conqueror lease. Van Dieman and associates operate another portion of the Free Coinage property, through the Parker & Gardner and Maloney shafts on the Orphan Bell group of the Empire Lee Company. Golden Conqueror Company also maintains production from this property.

▶ The Longfellow Mining Company has taken a lease from the Stratton Cripple Creek Mining & Development Company and has moved the hoist on the Moon Anchor property to the Longfellow shaft. The headframe and buildings are also being rehabilitated. H. C. Nelson, of Victor, is in charge of the work for Boston interests.

▶ A new power cable is to be installed from the surface at the collar of the Portland No. 2 shaft to the 26th level of the Ajax mine of the Golden Cycle Corporation, and when completed a new 900-gal. pump recently set at the 26th level will be put in operation to maintain improved pumping facilities.

▶ Butterfly Consolidated Mines, Inc., of Milwaukee, under general management of Walter Binner, have put on a third shift. This property is near Telluride, and was greatly handicapped by heavy snow last winter, yet operated steadily. The mill is treating 110 tons of ore daily. A new jig is being installed in the plant to improve recovery. C. L. Brown is in charge of mining operations, and Walter Hudson is mill superintendent.

▶ The Alta property at Telluride is also working steadily and employing over a

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▶COLORADO

hundred men at the mine and mill; twelve cars of concentrates are shipped monthly, according to Frank Allen, superintendent. The company is making plans for a larger mill.

▶ A. J. Johnson is resuming operations at the Ridgway mine, in Maggie Gulch, at Silverton, where new machinery will be installed.

▶ Operations at the Revenue mine were resumed, and a three-compartment raise of 600 ft. is being driven in the footwall of the Cumberland vein, according to J. W. Belcoe, general manager. Snow was extremely heavy last winter. Work at the Banner tunnel is expected to start in July.

▶ John Gilheaney, operating the Little Fanny holdings under bond and lease, is preparing to open the property. He plans to construct an aerial tramway between the Little Fanny tunnel and a location in Cunningham Gulch, between the Green Mountain and Pride of the West mines. G. A. Franz and associates have acquired the Rouville group of claims owned by Ernest and Paul Hoffman, of Silverton, and a group of claims known as the Meldrum. Both properties are situated on the famous Red Mountain and are in virgin territory. Machinery is now being installed for summer operations.

▶ The Old Hunter Creek Mill, at Aspen, Colo., will resume operations in July. Otto Johnson has a crew clearing the Veteran tunnel and repairing structures to handle 125 to 200 tons daily.

▶ Goldridge Mining Company expects to complete its 100-ton mill above Central City early in July. H. W. Thompson, of Central City, is mine superintendent.

IRON COUNTRY

Ore Shipments Expected To Increase Soon

Rise looked for beginning this month as the steel industry anticipates improved business during latter part of year

▶ The Oliver Iron Mining Company has placed its operations on a three-day basis instead of four as during the previous month. Also, it is understood that the Corporation ore schedule has been cut recently.

▶ The estimated ore shipments for the Lake Superior district will be low this year, and it is now being estimated that the total shipments will run around 15,000,000 tons, or about 50 per cent lower than was estimated by several statisticians at the beginning of the season. Shipments from the Lake Superior district to June 1, 1938, were 1,441,217 tons, compared with 13,814,411 tons in 1937. This explains the big drop in iron-ore production during the 1938 season. After July 1, however, it is expected that shipments will increase, reflecting improved demand for ore to satisfy larger requirements in the steel industry expected during the last half of the year.

▶ At present few ore carriers are in operation on the Lakes, and the latest *Marine News* shows that 123 vessels out of 308 are in operation—with only 87 actually in the ore trade, whereas last year the full fleet was handling iron ore. The Pittsburgh Steamship Company has 30 boats out of 79 operating, the Inter-Lake Company 18 out of 45, Hutchinson 8 out of 22, Cleveland-Cliffs 6 out of 24, and Bethlehem 12 out of 16.

▶ The Taylor Mining Company is doing some work at the Burns mine, at Eveleth, Minn. This was a former underground mine and is being stripped for a small pit operation.

▶ The Cuyuna Realty Company recently subleased its Feigh iron-ore property, on the Cuyuna Range, to the Ashland Mining Company, a subsidiary of the American Rolling Mill Company. Oglebay, Norton & Company, of Cleveland, manage the mining operations of the Ashland company. The Feigh mine has been operated as an underground mine by other operators in past years and had a stockpile of about 50,000 tons at the mine for several years until a year or so ago, when the Republic Steel Corporation purchased the ore in stock. The property may not be equipped for operation for two or three years.

MICHIGAN

Development at Michigan Mine Encouraging

Diamond drilling and drifting on copper property by Calumet & Hecla determine favorable indications—Large area photographed in aerial survey

▶ At the Michigan mine, in Ontonagon County, under option to Calumet & Hecla Consolidated, developments to date are encouraging. Drifting is proceeding in both directions from the fifteenth level of "E" shaft, and the property also is being diamond drilled. Michigan is noted for its rich "stretches," and the miners recently cut through one of these. The rock is unusual in high percentage of copper. If there are enough of these "stretches" and they are close enough together, Michigan can be profitably worked. Work now under way will determine this. It is understood that the diamond-drill results to date also are encouraging. In Keweenaw County, Calumet & Hecla has suspended work on the St. Louis and old Central explorations.

▶ The Michigan State Tax Commission has announced a reduction of $217,491 in the assessed valuation of copper mining properties in Houghton and Keweenaw counties. Total valuation was fixed at $8,533,500. Houghton County properties are valued at $6,871,000. The largest holdings are those of Calumet & Hecla, valued at $4,850,000, a reduction of $165,000 from the 1937 figure. Keweenaw County valuations were fixed at $1,662,500, an increase of $112,500. Calumet & Hecla properties in that county were assessed at $1,532,500, an increase of $87,500. Refined copper on hand in Houghton County was valued at $556,000. Of this, Calumet & Hecla was assessed for $437,790, Copper Range for $93,600, and Quincy, $24,610. According to Chairman John S. Fegan, the mining companies have assured the commission that "every dollar saved in taxes will result in that much more continued employment for miners this year." This factor and the depressed copper market determined the policy of the commission, he said.

▶ The second assessment of 50c. called by the Isle Royale Copper Company (Michigan company) was due and payable June 20. The dewatering of the mine has been completed and mining of copper is expected around the first of July. Ground previously opened will be mined, thereby cutting costs until an improvement in the metal market permits of the opening of new areas.

▶ Approximately 3,300 square miles in Houghton, Keweenaw, Ontonagon, and Baraga counties have been photographed from the air as the preliminary step in the preparation of maps which will be valuable for a variety of purposes, one of which is geological exploration. The project is a cooperative job between the United States Geological Survey and the Geological division of the Michigan Conservation Department.

▶ The Mid-western section of the American Society for the Promotion of Engineering Education will hold its annual meeting at the Michigan College of Mining and Technology in Houghton, Oct. 7 and 8. Prof. George Swenson, head of the electrical department of "Michigan Tech," is the president of the section.

TRI-STATE

Two Zinc Smelters Close Temporarily

Recent improvement in zinc industry, however, heartens producers, and outlook appears brighter

▶ Production of zinc concentrates in the Tri-State district was reduced from 6,000 to 4,000 tons per week during June, when most of the major companies went on a half-time schedule. One company is operating two weeks out of the month and the rest have gone on a three-day week. Stocks of concentrates have continued to build up, as many of the operators refused to sell their concentrates at the lower prices. Improvement, however, in the metal market during the latter part of June has encouraged disposal of some of this stock.

▶ A near cloudburst early in the morning of May 29 caused several of the small streams of the district to rise above the protecting dikes and flood several mines. The new York mine of the Cortez-King Brand Mines Company

lost one mule by drowning, but was able to rescue seven others. Lightning, accompanying the storm, damaged the motor and destroyed the pump house at the Muskogee shaft near Quapaw, Okla. This is a central pumping unit used for unwatering the area southeast of Picher. The 14-in. Pomona turbine pump which had been installed to unwater the area after the 1932 shutdown has been replaced with a 10-inch Pomona pump of 1500 g.p.m. capacity. This will be large enough to take care of the present inflow.

▶ The tailings re-treatment mill of the Britt Milling Company, a mile and a half southwest of Cardin, Okla., was reopened early in June after a two-month shutdown. The operation employs about 35 men, according to Carl Britt, company manager.

▶ The Skelton Lead & Zinc Company placed its mill at Century, Okla., in operation June 6. The mill treats a combination of tailings and mine ore. Approximately 85 men were reemployed.

▶ Mines and mill of the Rialto Mining Corporation, south of Cardin, Okla., were shut down the middle of June for a period of two weeks while alterations were completed to handle tailings. The mill was expected to start re-treating tailings about July 1, according to Sam Ashe, company secretary.

▶ Eagle-Picher Mining & Smelting Company has announced the closing of its zinc smelter at Henryetta, Okla., on June 1 for an indefinite period. The zinc smelter of the Arkansas Smelting Company, at Van Buren, Ark., was also closed early in June. Approximately 150 men were employed at the Van Buren plant and 300 men at Henryetta.

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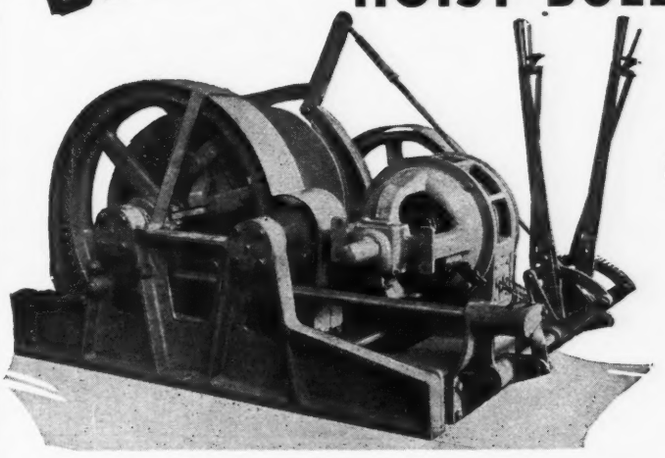

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MEXICO

Mining Continues Steady In Most Regions

Effects of business depression in country being closely watched by mining industry —Ministry of Finance will fix value of metals each month for tax purposes

▶ General slowness, a reflection of the acute economic depression in the country, a slump that has become more and more intense since expropriation of the foreign oil companies, marked mining in Mexico with the coming of summer. The industry is observing possibilities of an early settlement of the oil question, but up to now rumors are about all that is progressing in that regard. Mining men are watching the progress of the oil companies' appeal to the Federal Supreme Court of the rejection by a Mexico City district court of their suit for an injunction against the expropriation decree. Banditry has victimized some mining companies. Until these outrages, bandits were rather inactive in Mexico. There have been interesting court decisions affecting the industry and small development works are under way in some regions.

▶ The national miners' union has organized miners of the Nueva Rosita sector, Coahuila, as a militia. These miners are being armed and are to receive regular military training.

▶ The Federal Supreme Court has permitted the Cia. Minera Las Truchas, S.A., to continue operations at Las Truchas, Michoacan, pending consideration of appeal from cancellation by the Ministry of National Economy of its concession. The ministry contends that the franchise is based on a doubtful right to the property.

▶ Authorization has been granted by the Federal Government to El Oro Mining Company to discontinue service on the railroad 26 km. long that it operated for several years between El Oro and Bosecheve, State of Mexico. The company asserted that operation of the railroad is unprofitable.

▶ Good gold-silver deposits discovered on properties in the El Oro sector, State of Mexico, that employees of Dos Estrellas Mining are working on a cooperative basis for eight months ending in August, assure success of this labor experiment, declares the national miners' union.

▶ Prospectors employed by companies or individuals are protected by the labor law, according to a recent decision of the Federal Labor Department.

▶ Rich gold placer deposits have been found at Calmalli, an old mining zone in northern Lower California, according to a report to the national miners' union.

▶ A longer term for discussing a new collective labor contract providing higher wages and numerous other concessions demanded by workers has been granted Cananea Copper, Cananea, Sonora, by the national miners' union. A strike was averted by this concession.

▶ Exploitation of properties in several parts of central Mexico is to be undertaken by a new company, Trust Minero y Metalurgico, S.A., de C.V., Bonifacio Gutierrez Gonzalez, general manager, which has established headquarters in the Edificio San Marcos, Bolivar, 34, Mexico City.

▶ Mining companies are being affected by banditry. A payroll truck was robbed of 122,000 pesos (some $28,000) by twelve outlaws while on the way to the Santa Barbara and San Francisco del Oro workings from Parral, Chihuahua. The bandits had to abandon a large amount of silver pesos, but they shot and wounded the cashier of the bank who was in charge of the payroll. El Cubo Mining Company lost 15,000 pesos (about $3,500) in gold dust when its truck was held up between El Cubo and Guanajuato City. Nobody was injured.

▶MEXICO

▶ Six persons, including a nine-year-old girl, shot through the heart while running for help, were killed and eighteen others were wounded when a quarrel between two groups of prospectors developed into a gun fight at the La Pompeya property, near Coyuca de Catalan, Guerrero.

▶ Congress has authorized the Ministry of Finance to fix monthly the value of metals and metallic compounds for tax purposes on the basis of the average of prices on the New York market and quotations in pesos of the dollar by the Bank of Mexico during the previous month.

▶ When the Bank is not quoting foreign exchanges, as is now the case, the ministry will fix the value of metals and metallic compounds on the basis of New York price averages and the average rates for dollars trading in Mexico.

▶ The Federal Board of Conciliation and Arbitration must always verify a company's contention before granting authorization to suspend work because it is unprofitable, declares a ruling by the Federal Supreme Court in granting the petition of the national miners' union to set aside the suspension permit granted Cia. Minera y Beneficiadora del Norte, S.A., operating at Mineral Veta Grande, Zacatecas.

▶ The national miners' union has embargoed property of the Cia. Minera El Salto, S.A., at El Salto, Chihuahua, to guarantee payment of compensation for discharge of its employees. Company has asked for a Federal permit to quit, contending that work is unprofitable.

▶ Problems of mining industry workers were presented to President Lazaro Cardenas by officials of the national miners' union at an interview in Tampico. The President took matters under advisement.

▶ Operations are expected to start this summer in the Tominil mine, a gold-silver property at Tominil, Durango, under the direction of Manuel Montana. A 50-ton flotation plant is being installed.

▶ Fifty employees have been laid off by the Cia. Minera La Libertad, S.A., at La Campana, Sonora, J. E. McIntyre, general superintendent, and Manuel Zazueta, mine superintendent.

▶ Better living conditions for employees, in the form of running water, drainage, and model houses, are being provided by San Francisco Mines, San Francisco del Oro, Chihuahua, Henry B. Hanson, general manager.

▶ San Luis Mining, Tayoltita, Durango, is installing milling equipment supplied by Hamilton, Beauchamp & Woodworth, San Francisco, Calif.

▶ The Secretary of Communications and Public Works announced late in June that more time will be required for a complete examination before proposing higher freight rates for the mining and metallurgical industry. If the ruling should be adverse, miners will have to pay the back rates beginning June 22.

Foreign Copper Output Cut to 95 Per Cent

Official announcement was made in London on June 17 that the producers of copper operating under the foreign production and marketing agreement will decrease output to 95 per cent of the basic tonnages, effective July 1. Changes in the production rate by this group since August, 1936, follow:

	Operating Rate, %
Aug. 1, 1936	75
Oct. 1, 1936	80
Oct. 15, 1936	85
Nov. 1, 1936	95
Nov. 6, 1936	105
Jan. 14, 1937	Unlimited
Dec. 1, 1937	105
July 1, 1938	95

Output of copper is expected to decline about 7,000 tons per month with cartel operations on the new basis, making production around 63,000 tons per month by that group.

CANADA

Gold Production Rapidly Climbing

About thirty new gold mills estimated to come into operation this year—Large copper-gold orebody believed found on Waite Amulet

▶ "The greatest stimulus to an upward movement in our economy is the mining industry," said the Hon. Charles Dunning, Canadian Minister of Finance, in submitting the new budget before the House of Commons on June 16. It was pointed out that the Dominion Bureau of Statistics index of mine output increased by 18 per cent from January to April of this year, with the April figure almost 15 per cent above that of the same month a year ago, "which would appear to forecast the impetus to general economic recovery which may be expected from the industry during the balance of the year. In this connection it is estimated that 30 new gold mills will come into operation during 1938, increasing existing capacity by more than eleven per cent." Production records for gold and the base metals are impressive. The monthly average gold output in 1929 was 155,000 oz.; in 1937 it was 345,000 oz.; and the figure for April, 1938, was 368,439 oz. Nickel production in 1929 averaged 8,000,000 lb. a month, compared with 20,000,000 lb. last April. Recently, however, sales have been falling off to such an extent that International Nickel has closed three electrolytic units at Port Colborne, and further curtailment is expected in the Sudbury district.

▶ A few days after the Minister of Finance paid tribute to mining as a stabilizer of the Dominion's economic life, the Department of Mines and Natural Resources released details of a mass attack to be made this summer by 58 field parties in studying every mineral-producing province in the country.

▶ The Royal Canadian Mint reports that gold was sold in May at an average price of $35.22 in Canadian funds, the highest rate for any month since December, 1935. Average quotations for the last three years have been $35.19 in 1935, $35.03 in 1936, and $34.99 in 1937.

Quebec

▶ An important program of depth development has been in progress at McWatters Gold Mines, east of Noranda, for the last four months. Diamond drilling from the sublevel at 460 ft. indicated a sizable orebody, the first to be discovered below the 150-ft. level. A winze was sunk to 900 ft., followed by crosscutting on the 712 level to intersect the new ore north of the shaft. The new ore averages $10 across widths up to 20 ft., for a length of more than 200 ft., on the 600 sublevel. Downward extension is indicated at least to 850 ft. Late in June new equipment was installed capable of reaching down to 1,400 ft., and a new shaft to the north is under consideration. W. V. Hosking, is manager.

▶ Last December a program of diamond drilling was started by Lake Dufault Mines under the direction of J. G. MacGregor, president and consulting engineer. The objective was the rhyolite-andesite contact down the dip from its outcrop to the west near the Amulet mine. Deepening an old vertical hole near the Waite Amulet boundary, the contact was found at 1,000 ft. In the second drill hole, located 150 ft. east of the first, massive sulphides 4 ft. wide appeared in the contact zone. Quick to act on this information, Waite Amulet started a hole down 15 ft. from the boundary and 400 ft. north of the Lake Dufault set-up. The results from this and the next four holes drilled by Waite Amulet have indicated an orebody that justifies comparison with high-grade cores pulled by Noranda in the early days. Nothing similar to these copper-gold values has been found anywhere else in Canada. J. G. Murdoch, president of Noranda Mines (controlling Waite Amulet) intervened when the fifth hole had been drilled and ordered that no more publicity be given to core assays. In the meantime, four drilling machines were operating on Amulet ground and two on the Lake Dufault side of the boundary. In No. 4 hole on the Amulet, high-grade was encountered at a vertical depth of 815 ft. No. 3 cut 165 ft. of vertical core averaging 8.9 per cent copper and $2.45 in gold, located 100 ft. north of No. 4. No. 2 drill hole, 100 ft. north of No. 3, gave 105 ft. of vertical core that averaged 4.8 per cent copper and another 22 ft., averaging 4.2 per cent, with gold values around $1. No. 1 hole was located 150 ft. east of No. 2, returning core that assayed 1.8 per cent copper and 7.1 per cent zinc across 35 ft. Tonnage suggested by this preliminary work is probably in excess of all known orebodies on Waite Amulet ground. Indications of improved values to the southwest along the strike of the contact are now being checked by intensive exploration, on ground held by Waite Amulet and by Big Four Mining Syndicate.

Ontario

▶ The annual report of Omega Mines, pioneer Larder Lake producer, which

last year treated a daily average of 439 tons of low-grade ore, shows that possibilities exist below the 1,050-ft. level for developing a large tonnage carrying improved values. J. P. Bickell, president, states that diamond drilling below the bottom producing horizon has traced two parallel veins that indicate a gold content well above mine average.

▶ The proving of ore structure to a depth of 1,800 ft. at Pickle Crow Gold Mines has led to rapid development below the former bottom level at the 1,200-ft. horizon. Following shaft sinking to 2,000 ft., five new stations had been completed early in June and crosscuts were being pushed out toward the main vein on the 1,350, 1,500, 1,650, and 1,800 levels. J. E. Hammell, president, states in a recent letter to shareholders that ore reserves above the 1,200 level are adequate for at least three years' milling operations, the gold content being close to the average mined last year, $20.47 per ton. Alex G. Hattie is mine manager.

▶ Sachigo River Exploration Company, always the pet child of Lady Luck, is opening up sections on the third level better than anything yet run through the mill. Ore from this bottom level has averaged as high as 5.75 oz. of gold on a day's run of 30 tons, and samples across full drift width on the east face assay 5 oz., according to the management. Only a couple of years ago the property had little to distinguish it from other areas of muskeg far north of the railroad. With no outcrops to explore, assessment work had to be done with a diamond drill, which cut into the orebody in a blind hole. A small group of Toronto and Manitoba mining men advanced $180,000 to put the mine into production, and it is calculated that the loan can be paid back with ore now available on merely the bottom level.

British Columbia

▶ Machinery worth $80,000 has been ordered by Privateer Mines, Ltd., for the 75-ton mill to be constructed at its sensationally rich gold mine in the Zeballos area, on the west coast of Vancouver Island. D. S. Tait, secretary, reports that at the 800 level ore has been opened for a length of 200 ft., averaging 6 or 7 oz. gold per ton. The portal of the 1,100 level, which will be the main entry, has been completed and a crosscut is now being driven towards the vein, 560 ft. ahead of the face. Rapid progress is being made in preparations for the construction of a new bunk house, a power house, and a mill building.

▶ At other properties in the Zeballos area work is proceeding satisfactorily. Man-O-War Mines, Ltd., is obtaining good results at both its groups, the Rimy and Van Isle, and it is planned to ship crude ore soon. No. 3 vein at the Rimy has been opened in an open cut for a length of 30 ft., carrying values of from 1 to 5 oz. across widths of 4 to 7 in. Connell Mining & Exploration Company, of Toronto, has installed a small mining plant at the B. X. group, and two adits are being driven to open the vein, which has been traced for a distance of 1,000 ft. on the surface. Inspiration Mining & Development Company, of Montreal, is developing an unusual occurrence at the Beano group, where values are carried in sulphides in decomposed segregations of what was probably originally gabbro. Elsewhere in the camp the commercial deposits have been found in granodiorite or volcanic rocks.

▶ In the Woss Lake region, 15 miles inland from Zeballos, Vancouver Island Exploration Syndicate has staked about 100 claims, covering for a length of 6 miles the contact of a wide greenstone embayment into granodiorite. C. P. Riel, directing operations, reports that seven showings have been exposed and work is being concentrated for the present on the most promising. The entire area will be prospected thoroughly this summer. One of the syndicate's groups was examined recently by a representative of the Mining Corporation of Canada.

▶ Dredge mining enterprises may be undertaken in several parts of the Province within the next few years if the results of present drilling tests prove encouraging. In the Cariboo district at least two important tests are being made, one by Yuba Consolidated on Williams Creek near Barkerville, and the other by the Dole interests on Horsefly River. In the Omineca district a property on Musket Creek 100 miles north of Prince George is being drilled for the fourth season by J. A. Warburton and associates, of Montreal.

▶ Considerable interest was shown by operating companies this spring in the possibilities of lode deposits along the Barkerville Gold Belt, traced for 20 miles from the Island Mountain and Cariboo Gold Quartz mines at Wells southeasterly to the Cariboo Hudson. The value of output at Cariboo Gold Quartz was $131,215 in May, and at Island Mountain, $51,065. A 100-ton mill is being built at Cariboo Hudson. Among the properties being examined by outside interests are the Shamrock, near Barkerville, and the Richfield-Cariboo.

▶ Limestone replacement ore, similar to that developed at the Island Mountain, has been found at the Quesnelle Quartz, situated in the Hixon Creek region, 50 miles to the northwest. A length of 75 ft. has been opened at the 400 level, averaging about $20 in gold per ton. A 25-ton pilot mill is being built, and will probably be ready for operation early in July. T. Norton Youngs is in charge.

▶ Construction of a 150-ton mill at the Gold Belt mine will be commenced soon, and it is expected to be completed early in September. H. Grattan Lynch, engineer representing North American Mines, Inc., which is financing the venture, estimates that 83,000 tons of ore, containing about 50,165 oz. of gold, is now in sight in the 8,000, 8,200 and 6,000 veins, and by Sept. 1 this should be increased by 25,000 tons.

▶ The 25-ton mill and power plant of Reward Mining Company at the Surf Point mine, near Prince Rupert, were destroyed by fire on June 17. John D. Galloway, managing director, reports that in the 13½ months ended March 31, 1938, net revenue was $125,397 and net profit, $9,160. The ore position was greatly improved during this period.

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YUGOSLAVIA

Lead and Zinc Smelters Planned by Trepca Mines

Negotiations under way with Yugoslav Government, and if satisfactory arrangements are made Trepca will be a major lead-zinc producer

▶ Trepca Mines, Ltd., is working out a plan for the erection of lead and zinc smelters in Yugoslavia. Negotiations to this end have been in progress for some time with the Yugoslav Government. When and if agreement is reached it is proposed that Trepca shall absorb its three associated companies—Kopaonik Mines, Ltd., Novo Brdo Mines, Ltd., and Zletovo Mines, Ltd.—by an exchange of shares, thereafter issuing about 1,600,000 Trepca shares to finance the construction of the smelters. By absorbing Kopaonik, already a producer, and Zletovo, about to start production, Trepca will become one of the world's largest lead and zinc producers. Trepca has declared an interim dividend of 3d. per share, free of income tax, on account of the year to end Sept. 30, 1938. It milled 52,867 metric tons of ore in May, producing 5,736 metric tons of 78.81 per cent lead concentrates averaging 27 oz. of silver per ton, and 5,735 tons of 50.44 per cent zinc concentrates. Its annual output of concentrates thus contains over 54,000 tons of lead, 34,000 tons of zinc, and 1,850,000 oz. of silver.

AFRICA

Orange Free State Has Gold Possibilities

Exploration by large companies indicates existence of substantial gold bearing reefs —Five companies in West Africa consolidate

▶ Drilling in the Orange Free State, approximately 165 miles from Johannesburg, has furnished a first-class mining sensation. Two or three years ago Sir Abe Bailey secured options over a considerable area and formed Western Holdings, Ltd. In the meantime the Union Corporation and the Selection Trust (an A. Chester Beatty organization) were also acquiring adjacent options, and in the same locality Western Reef was drilling. Recently the Western Holdings cut 8½ ft. of reef at a depth of about 2,000 ft. assaying 3.37 dwt., and another at 2,417 ft., the first sampling of which showed 11.3 dwt. over a true width of 10 ft. However, a reassaying of the latter returned only 2.68 dwt., the wide difference indicating the presence of coarse gold. This discovery brought to light the interesting facts that Union Corporation and Selection Trust had secured large holdings of Western Holdings and in these, as also in the large areas the two have under option, they have a 50-50 arrangement. It is declared that Selection Trust had been searching for five years for a gold mine and found nothing it cared to sponsor until its officials recognized the possibilities of the Orange Free State. One authority points out that of four boreholes completed in the areas adjacent to Western Holdings, three have disclosed payable values, so great hopes are entertained for the results of the several other holes now being drilled. As the reefs there are tilted to 60 deg. and in some cases to vertical, the possibility of making two or more cuts from a single hole by diverting the drill is being considered. It is also being said that the development of the deeply seated gold reefs in the western Rand and Orange Free State has been made practicable by the discovery of a method of cementing off the water seepage from the overlying dolomite.

▶ Plans have been adopted for the consolidation of five West African companies the properties of all of which are in the exploration and development stage. They are Apollonia Gold Fields, Gold Coast Associated Companies, Oboum Gold Mines, Tarkwa Banket West, and Tarkwa Gold Mines. A new company will take them over by an exchange of shares, later liquidating them and assuming their combined liabilities of some £41,705. Presumably new capital will thereafter be raised for development work, as the value of the properties has yet to be determined.

▶ Rhodesia Broken Hill Development Company's operating profit for 1937 was £156,035, against £97,840 in 1936. Net after provision for income tax and writing off development and other expenses was £127,270, and this was carried forward. The company has £541,687 net quick assets, from which it will make heavy expenditures this year and next in sinking shafts and developing the rich ore proved at depth by drilling. As the deep ore is partly lead and zinc sulphides, a flotation plant will be erected.

▶ An agreement entered into by the Southern Rhodesia Government and De Beers Consolidated Mines provides that the latter shall relinquish gradually its diamond concession granted in 1892. It will abandon 7,500 square miles annually. This being one-twentieth of the Colony's total area, the concession agreement will be wound up in twenty years.

▶ A detailed statement of operating results of the Witwatersrand mines in 1937, compared with those of 1932, was made by the chairman of Central Mining & Investment at the annual meeting, and, tabulated, they are as follows:

	1937	1932
Tons ore milled	50,725,000	34,906,000
Average milling grade (dwt.)	4.462	6.472
Decrease, %	31	
Gold production (ozs.)	11,445,000	11,378,000
Gross value	£80,520,000	£48,181,000
Increase, %	67	
Working costs per ton	18s. 11d.	19s. 2½d.
Profits before taxes	£31,704,000	
Increase, %	116	
Dividends paid (Almost doubled)	£17,015,000	
Cost of stores consumed	£29,000,000	£16,000,000
Increased per ton milled, %	3.4	
White employees	39,160	23,771
Native employees	288,962	221,008

▶ The decreased grade of ore results from the higher price of gold, making

lower grade payable, and mining over greater widths, and the larger tonnages treated account for the slight reduction of costs. Again, the higher price of gold more than doubled working profits and, despite greatly increased taxation, enabled nearly double the amount to be paid in dividends from approximately the same volume of production. These figures cannot fail to bring before the mental vision of the practical mining man a new and vitally interesting picture of the future of the Rand.

AUSTRALIA

Government Prohibits Iron Ore Export

Effective July 1, no shipments will be permitted, as reserves determined are limited—Big Bell investigating molybdenum deposits

▶ Official returns show that Australian gold production for the first quarter of the year was 362,535 oz. This is an increase of 53,792 oz. over the yield for the corresponding period of 1937. The only April figures so far released are those for Western Australia, 94,656 oz., making the first four months' production 367,173 oz., more than 60,000 oz. greater than that in 1937; and for Queensland, which with an April yield of 11,734 oz. made a total of 44,902 oz. for the four months, a 33 per cent increase over the 1937 figure.

▶ Acting on the advice of its geological adviser, Dr. W. G. Woolnough, the Federal Government has decided to prohibit the exportation of iron ores from Australia after July 1. The Prime Minister, J. A. Lyons, in making this announcement, stated that the Government expected to proceed, in collaboration with the States, in a complete detailed survey of the iron-ore resources of the Commonwealth, but pending the completion of such a survey, it felt that, on the information before it at present, it had no option but to follow the course announced. The report by Dr. Woolnough, which formed the basis for the Government's action, declared that the two largest and most readily exploitable deposits—namely, those at Iron Knob, S. A., and Yampi Sound, W. A.—contained a probable total of only 250,000,000 tons, enough to last the country, with a rate of production which may reasonably be anticipated, for possibly 50 years only. There are many other deposits, but all are considered to be commercially unsuitable for exploitation, by reason of small size, grade, or inaccessibility. The principal activity affected by the decision is that of Yampi Sound Mining Company, where developmental operations directed towards the exportation of 1,000,000 tons of iron ore yearly to Japan were in active progress.

Western Australia

▶ Accounts of Boulder Perseverance, Ltd., Kalgoorlie, show that the net profit for 1937 was £82,057 sterling, an increase of £26,816 compared with the 1936 figure. The dividend was increased from 25 to 40 per cent, which was paid on a capital increased by 50 per cent. Tonnage treated was increased by 12,343 tons to 110,069 tons, grade being slightly higher at 8.29 dwt. The mill, operated by Kalgurli Ore Treatment Company, Ltd., showed greatly improved results, with a recovery increase from 87.3 to 92.9 per cent and a reduction in cost from 14/9 to 13/4 per ton. Total costs for mining development and treatment were reduced by 2/10 per ton. A further reduction of mine costs (exclusive of treatment) of 10d. per ton is forecast for the current year. Development of the Enterprise leases for ore production has begun, although, owing to delay in completion of treatment-plant extensions, it has not yet been possible to treat the Enterprise ore; however, this position should be reached soon.

UNCERTAIN OUTCOME FOR CHOSEN CORPORATION

THE SALE of Chosen Corporation's mines to Japanese interests has been held up, and the £350,000 deposited in a London bank, assumed to be the first payment on account, has yet to be released. Meanwhile a back taxes claim for approximately £200,000 against one mine, Nurupi, has been sanctioned by a Japanese court and appealed. Negotiations are continuing.

ONE DIFFICULTY apparently is that of getting permission to transfer any large amount of sterling exchange from Japan, due to the trouble in China. Chosen shareholders are becoming restless. A long delay seems probable, and the outcome is uncertain.

▶ In March, Big Bell Gold Mines recovered 7,496 oz. of gold, making for the first quarter of the year 18,417 oz. This output is at an annual rate of about 30 per cent in excess of that expected from prospectus estimates. The company is reported to have taken an option on molybdenum deposits at Mount Mulgine, 60 miles south of Yalgoo. These deposits were worked by high-graders, but were abandoned many years ago on the depletion of the better quality ore. They are, however, believed to contain considerable tonnages of 2 to 5 per cent ore that could be concentrated by flotation.

▶ Prospectors have located a promising new gold find near Riverina, 30 miles west of Menzies, which is about 80 miles north of Kalgoorlie. The orebody is said to have been discovered by accident, due to an involuntary halt with a stalled truck and casual examination of a nearby outcrop. Little work beyond surface sampling has yet been done, but quartz is said to be outcropping for about four chains, and several leases have been pegged out. The discovery claim, with

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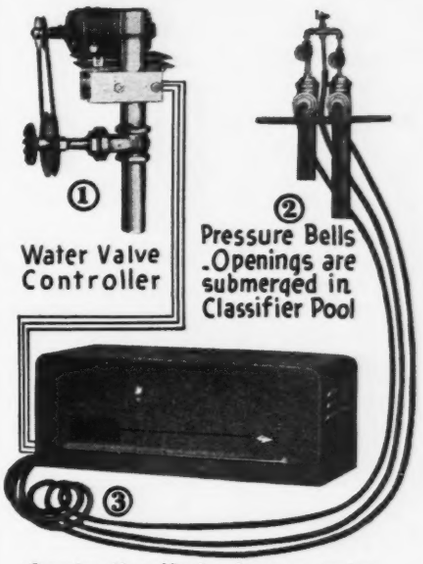

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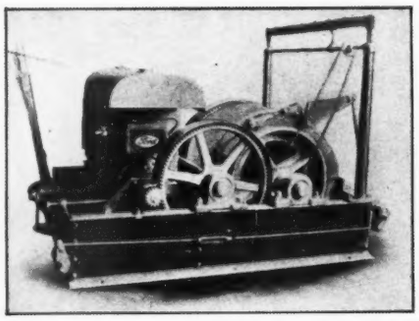

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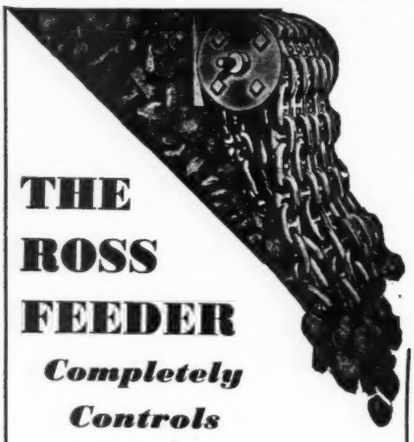

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▶AUSTRALIA

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Victoria

▶New Chum Syncline, N. L., which a few weeks ago intersected a promising reef formation on the Nell Gwynne line, has had encouraging results in developing the reef, which is believed to be the same as that being worked so profitably by Central Nell Gwynne, the adjoining mine on the south. Trial crushings totaling 265 tons taken from the north and south drives at the 1,020-ft. level have yielded 560 oz. of gold, a grade of more than 2 oz. per ton, and the ore is strong in the development faces, with gold showing freely. There is at the moment every indication that this discovery is one of the bonanzas which periodically put new life into the Bendigo field, and that it will have a stimulating effect generally on mining in the district. Already a new company, Golden Sovereign, N.L., has been formed to develop the more northerly part of the Nell Gwynne anticline, which has hitherto been neglected as not being one of the major "lines" of Bendigo.

▶Three years ago it was believed that the extensive systems of "deep leads," or buried alluvials, which exist in Victoria would provide another avenue for development of the expanding gold-mining industry. Today, however, it must be admitted that these hopes have not been realized, and the latest development has been the abandonment by Gold Mines of Australia, Ltd., of extensive areas held by it in the Allendale district, north of Ballarat. After spending £70,000, in conjunction with Gold Exploration & Finance Company of Australia, Ltd., in thorough testing of the areas, the company has evidently come to the conclusion that the results obtained were not sufficiently attractive to induce it to proceed with the further development of the leases. The risk rate associated with this form of mining is undoubtedly a high one, as although boring can demonstrate the existence of a lead, its values cannot be determined without actually opening up the area for mining, involving a heavy capital expenditure in the provision of shafts, an extensive system of drives and rises, and considerable pumping equipment.

▶Shortage of water in the northeast has resulted in curtailment of alluvial operations in the district. Cocks Eldorado Gold & Tin Dredging, N.L., was forced to suspend operations for a short period because of lack of sufficient water, and now Cocks Pioneer, the sluicing company which stopped work to reorganize its scheme of operations some months ago, is ready to resume operations, but cannot do so pending the falling of sufficient rain to fill its storage dams.

New South Wales

▶First regular return of Wellington Alluvials, Ltd., Macquarie River, shows that in the four weeks to April 30 the dredge operated for 199 hours, treating 66,000 cu.yd. for 469 oz. gold (3.4 grams per cubic yard). The dredge has previously run intermittently only, due principally to the prolonged dry season, which caused a severe shortage of water, and to the necessity of remodeling the overburden-handling equipment. Other dredges just going into operation are those of Cullengoral Alluvials, near Gulgong, which is an electrically driven machine of 70,000-cu.yd. monthly capacity, treating ground estimated to contain 2.8 grams per cubic yard; and Granites Development, N.L., at Glen Elgin (New England district), which has a capacity of 60,000 cu.yd. per month. The wash contains gold and tin estimated to be worth 15 pence (Aust.) per cubic yard.

Queensland

▶Work on the extension of plant at Mount Morgan is well advanced, and already the sulphide mill is treating 9,000 tons and the oxidized-ore mill 6,000 tons per week. It is expected that the smelter and the mill and power house extensions will be completed and in full operation early next year. Although another shipment of concentrates was made to the United States last month, difficulty is still being experienced in securing regular freighting, and the position is causing much concern, as irregularities in realization are causing delays in financial returns.

NEW GUINEA

▶W. J. Turner, after an examination of the Edie Mine of Enterprise of New Guinea Gold & Petroleum Development, N.L., considers that it is a low-grade property of considerable promise. The principal lode system, traceable on the surface for a distance of 4,800 ft., has been driven on underground for a length of 770 ft. only, with an average assay of 7 dwt. per ton over a width of 5 ft. Assuming its persistence for another 150 ft. in depth only (at which horizon a new drainage adit is being driven to intersect the lode), the amount of possible ore would be 262,000 tons. Mr. Turner is of the opinion, however, that geological evidence favors the continuance of the lode to a much greater depth than this.

FIJI ISLANDS

▶Shareholders of Koroere Gold, N.L., have accepted their directors' recommendation for a sale of the company's assets to Emperor Mines, Ltd. The new owners will soon commence open-cutting work on the Cardigan section of the property, but will probably defer deeper development until the Emperor mine itself is opened up at depth.

▶After recording losses in 1935 and 1936, Mount Kasi Mines Ltd., Island of Vanua Levu, Fiji, greatly improved its position in 1937, showing a net profit of £8,046. During the year 33,232 tons of ore were treated for 7,496 oz. gold (4.5 dwt. per ton). Working costs were cut from 44/9 per ton to 27/7. Ore reserves are set down at 261,000 tons averaging 5.4 dwt. per ton. The improved results are undoubtedly due largely to the able management of Major H. Peterson, who has been in charge of operations since November, 1936.

EQUIPMENT NEWS

Quick-Opening Sheave

DESIGNED TO SAVE TIME in slushing operations, Harley A. Coy, Mascot, Tenn., announces the Mascot sheave, that makes it possible for the operator to insert the rope on the ball-bearing sheave without removing pins or bolts. The side frames of the sheave are hinged and can be quickly opened for cable insertion, and when the sheave is hooked in the eyebolt the rope strain is said to be equalized on both sides of the unit. Made of cast steel, the sheaves are furnished with a sealed greased-for-life anti-friction bearing or with plain bronze bearings equipped for Alemite greasing. Ample space has been provided for passage of knots in case a broken cable or rope is repaired in that manner. Rigid construction of the unit will not permit the return ropes to twist and saw, as is common with sheaves with the swivel-type hook. Models are available in 8-, 10-, and 12-in. sizes that can be used for rope sizes ½ to ¾ in.

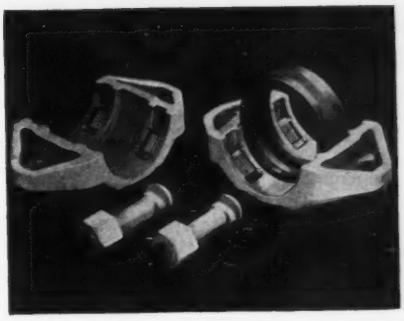
To provide a secure anchor in the rock for the rope sheave carrying the return rope to the hoist in slushing operations, Mr. Coy offers the Mascot "Saflex Wedgeye." This socket device can be placed in a drill hole and securely anchored by a steel pin. The socket has an 18 in., or longer, length of cable securely attached, and at the end of the cable is an eyebolt for the sheave hook. This cable permits easy adjustment to operate at any angle of pull.

Combination Meter And Time Switch

IN A SINGLE UNIT an accurate watt-hour meter and an improved Telechron-motored time-switch register are combined in the new IR-30, a combination unit just announced by the General Electric Company, Schenectady, N. Y. Savings in space, installation and maintenance costs, and inventory investment are among the advantages of the single-unit construction. Wide-limit accuracy is assured by incorporation, in the unit, of the established G-E I-30 watt-hour meter, which is suited for both large and small single-phase loads. The meter is available in all ratings, with any one of three registers: single-dial with contacts; double-dial with contacts; and double-dial without contacts. It is available for front connection or for socket mounting.

Pipe Coupling

SIMPLICITY of construction, strength, flexibility, durability, and ease of application on plain and beveled-end pipe are claimed for Rolagrip pipe couplings, manufactured by Gustin-Bacon Manufacturing Company, Kansas City, Mo. The coupling consists of two halves, two bolts, and a gasket, making for quick assembly and disassembly, without



the need for special tools. In joining two lengths of pipe, the rubber-ring gasket is first slipped over one end; the two ends are then brought together and the gasket is slipped to cover the joint. Over this, the two halves of the coupling are placed and bolted tightly. Rollers in the coupling housing are said to permit expansion and contraction of the pipe line, and a deflection of about 5 deg. can be accommodated. These couplings are said to withstand 1,000-lb. working pressure, temperatures up to 175 deg. F., and vacuum. They can be used on temporary as well as permanent water lines, as they have almost 100 per cent salvage or reclaimable value.

Respirator

DEVELOPMENT of a new type respirator which will prevent silicosis, if worn faithfully, has just been announced from the laboratories of American Optical Company, Southbridge, Mass. According to the announcement, the new respirator is the answer to extensive experiments, and is said to be designed

to provide for maximum comfort, so that workers will not object to wearing it. The respirator has been approved by the United States Bureau of Mines for Type-A dusts. New features as reported are: Compactness, light weight, unobstructed vision, facial adjustment unnecessary, improved valves which assure easy inhalation and exhalation, easy to keep in efficient working order, and a more effective filter area of 42 sq.in.

Arc-Weld Rail Bond

OHIO BRASS Company, Mansfield, Ohio, has developed an improved steel arc-weld rail bond for use in bonding mine and industrial rail. This bond, designated

as the AW-20 Hook-Type Rail Bond, differs from ordinary bond designs in that the pressed-steel terminal is bent at right angles to the direction of the strand. A small steel hook embraces the rail, holding the bond firmly in place while the weld is being made. The 4/0 strand is welded into the terminal and further secured in position by a copper sleeve. The bond is regularly available in 4/0 strand lengths of 12, 16, 20, 22, 24, 26, 28, 30, 32, and 34 in.

New Lightweight Jackhamer

INGERSOLL-RAND Company, Phillipsburg, N. J., announces a new Jackhamer, the JA-35. It is a light-weight yet extremely powerful drill, styled after the widely used JA-45 and JA-55. It is said to do a surprising amount of work per cubic foot of air used, and will readily handle all general light Jackhamer work with ease.

Weighing less than 35 lb., it is a light weight, easy holding, fast drilling machine that finds application in coal and metal mines, in quarries, and on construction jobs. It is said to be light enough for cutting hitches, trimming, taking up bottom, placing trolley hangers in a mine, pop-holing, and for much general work.

Rachet Rail Punch And Bender

THE GIBRALTAR Equipment & Manufacturing Company, Madison at 14 St., St. Louis, Mo., announces a new improved rachet-type rail punch. The improved design includes a fully closed rachet to exclude dirt and prevent "freezing" of working parts. It is also

entirely separate from punch screw, with no rachet teeth cut into the end of punch screw. The punch is said to operate fast and can be worked with very little effort. For use in connection with 20- to 40-lb. rails, the punch weights 30 lb., and for 20- to 70-lb. rails the weight of the unit is 34 lb.

The manufacturer's improved rachet-type rail benders are available for bending rails within the following three sizes: 12 to 25 lb.; 20 to 40 lb., and 40 to 80 lb. These improved rachet benders are said to permit rapid work in bending rails underground or on the surface.

BULLETINS

Hoists. Joshua Hendy Iron Works, 206 Sansome St., San Francisco, Calif. Bulletin 207 illustrates and describes the manufacturer's single- and double-drum hoists, skips, cages, sheaves, and safety devices. Pp. 6.

Dragline Gold Dredges. Bodinson Manufacturing Company, 2401 Bayshore Blvd., San Francisco, Calif. A handsomely made up book giving complete operating and technical description of the company's portable and floating gravel-washing plants, and auxiliaries such as pumps, winches, and divers gold-saving appliances. Pp. 20.

Optical Pyrometer. Bachrach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa. Bulletin 300 illustrates and covers recent developments in instrument engineering. Pp. 7.

Split-Krozure. Garlock Packing Company, Palmyra, N. Y. Bulletin describes and illustrates application of packing to bearings mounted on shafts carrying couplings, gears, or flywheels without removing these parts. Pp. 12.

Blueprint Paper. Keuffel & Eiser Co., Hoboken, N. J. Booklet describes the manufacturers' new "Series Sixty" blueprint papers. Pp. 11.

Pipe Tools. Beaver Pipe Tools, Warren, Ohio. Bulletin illustrates and describes the manufacturer's line of pipe tools. Pp. 7.

Pintype Insulators. Ohio Brass Co., Mansfield, Ohio. Bulletin 638-H describes and illustrates features of the company's Silentype design of insulators and shows equipped lines. Pp. 6. **Angle Clamp.** Bulletin 642-H describes assembly clamp for turning angles in line-wire installation.

Gear and Wheel Puller. Edelblute Manufacturing Co., Raynoldsville, Pa. Small folder illustrates various applications of puller unit for removing wheels, etc., from shaft, axle, or bearing. Pp. 2.

Socket Instruments. Westinghouse Electric & Manufacturing Co., Newark, N. J. Bulletin 2136 describes and illustrates installations, applications, and economies of "plug-in" instruments. Pp. 20.

Dust Arrester. The Northern Blower Co., Cleveland, Ohio. Bulletin 100-2 describes the manufacturer's cloth-screen type dust arrester. Pp. 4.

Industrial Mixers. Ransome Concrete Machinery Co., Dunellen, N. J. Bulletin 503 describes and illustrates mixers of ores in smelting practice and other industrial uses. Pp. 20.

Mine Traffic Control. Moseback Electric & Supply Co., 1115 Arlington Ave., Pittsburgh. Folder describes application and advantages of the Mesco Gill safety block-signal system.

Centrifugal Pump. Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin 1651-A describes and illustrates the manufacturers' types of centrifugal pumps for mining and other industrial uses. Pp. 50.

Titrimeter. Fisher Scientific Co., 711-723 Forbes St., Pittsburgh, Pa. Folder describes and illustrates the manufacturer's device employing a "magic eye" for more accurate volumetric analysis. Pp. 5.

Furnace Wall and Arches. Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo. Bulletin 301 illustrates and explains the manufacturer's design and solution of complex furnace and wall problems. Pp. 15.

Magnetic Separators. Dings Magnetic Separator Co., Milwaukee, Wis. Catalog 770 describes Dings Super-High Intensity Type IR induction magnetic separators and the Wings Type E cross-belt machines.

Hydraulic Dredge Accessories. Morris Machine Works, Baldwinsville, N. Y. Bulletin 172 shows pipe-line parts, fittings, and equipment for hydraulic dredges. Pp. 4.

Centrifugal Sand Pump. A. R. Wilfley & Sons, Inc., Denver, Colo. Folder describes the manufacturer's new pump without a stuffing box for abrasive solutions. Pp. 4. Bulletin E 1415 describes the new Model AB and AC acid pumps. Pp. 4.

Color as an Efficiency Tool. The Skybrite Co., Cleveland, Ohio. An illustrated catalog describes the advantages of use of color in shops and numerous other industrial applications for obtaining increased efficiency. Pp. 16.

Waterproofing Material. Flexrock Co., 800 North Delaware Ave., Philadelphia, Pa. Folder describes "Flextite," a material used in waterproofing cement cracks and holes against pressure. Pp. 3.

Generators. General Electric Co., Schenectady, N. Y. Bulletin GEA-1607B contains information on construction features and available ratings of Type B generators and exciters. Pp. 4. GEA-2052A describes track-type limit switch. GEA-2714 describes construction features of Type MR motors for crane and hoist service. Pp. 4. GEA folder gives ratings of magnetic motor controls and pushbuttons. Pp. 4. GEA-1542C describes Type B direct-current motors. Pp. 4. GEA-1440F illustrates and describes the G-E welder. Pp. 15. GEA-1437C contains data on integral and fractional horsepower gear motors for low-speed operation. Pp. 11.

Refractories. General Refractories Co., Philadelphia, Pa. Booklet is entitled "How to Reduce Spalling With Super Duty Refractories." It contains charts, tests, and general information. Pp. 10.

Tanks. Denver Equipment Co., Denver, Colo. Bulletin 3814 contains data on the manufacturer's bolted steel tanks for use at mines and in mills. Specifications on tray thickener tanks and pulp density tables are also given. Pp. 11.

Reconditioning Flooded Electric Equipment. General Electric Co., Schenectady, N. Y. GEA-2571-B is a comprehensive booklet containing information on how to clean and care for all types of electrical equipment that have been covered by water. Pp. 18.

INDUSTRIAL NOTES

Tennessee Coal, Iron & Railroad Company has been advised by the United States Bureau of Mines that the company's No. 5 limestone mine, at Muscoda, has won the "Sentinels of Safety" trophy for its safety record during 1937. This marks the second consecutive year that the trophy has been awarded to the local mine in competition with non-metal mines throughout the nation.

Caterpillar Tractor Company, Peoria, Ill., announced on June 20, 1938, liberal price reductions in its line of track-type tractors and diesel engines. The reductions in the tractor line affect all sizes except the Twenty-Two, the price of which had already been reduced $200 several weeks earlier. The acclaim with which that announcement was received encouraged the company to make similar reductions in the prices of other of its products, the reductions ranging from $150 to $650 on the several sizes of tractors and from $175 to $750 on the diesel engine line, affecting six of the eight current sizes of "Caterpillar" diesel engines.

Willson Products, Inc., Reading, Pa., well-known manufacturers of goggles, helmets, and respiratory protective devices for dust hazards, have just completed a half million dollar plant building program to take care of expanding business.

J. J. B. Rutherford, formerly of the research laboratory, United States Steel Corporation, Kearny, N. J., has joined the metallurgical staff of Babcock & Wilcox Tube Company as research metallurgist.

Allis-Chalmers Manufacturing Company, of Milwaukee, Wis., recently opened its own office in Mexico City at Calle Gante No. 7, to handle the sale of its general line of power, electrical, mining, crushing, cement, flour-mill, and other machinery for industry. R. B. Rodriguez is general manager in charge of the office.

Western Knapp Engineering Company announces the removal of its offices from 591 Market St. to 760 Folsom St., San Francisco, Calif.

Concentrating Southern Barite Ores

II

THE FIRST PART of this article, appearing in the June issue, described how the World War forced stoppage of barite imports into this country and consequently the demand of the manufacturers of lithopone and barium chemicals for barite stimulated the development of domestic deposits. Of the numerous barite deposits in the country only California, Georgia, Missouri, Nevada, South Carolina, Tennessee, and Virginia reported sales of barite in 1935. As the demand for lithopone and barium chemicals originates principally from Eastern consumers, many barite producers in the South have experienced difficulty in marketing their products because of the impurities in their ores. The Bureau of Mines, with the cooperation of the University of Alabama, began an investigation of the amenability of Southern barite ores to table concentration and froth flotation. The article continues the discussion of Ore K and the results of classification and tabling as shown in Table IV, presented in the June issue on page 106D.

Analyses for SiO_2 (Table IV) are not included in the data for this ore, silica being objectionable mainly as a diluent, so that the quality of a product can be judged by its $BaSO_4$ analysis. The first eight table zones from Spigot 2 gave a concentrate containing 94.0 per cent $BaSO_4$ at a recovery of 98.0 per cent. From the first six zones of Spigot 3 was obtained a concentrate containing 97.6 per cent $BaSO_4$ at a recovery of 90.2 per cent. The concentrates from the first fourteen zones, when tabling the overflow product, contained 96.2 per cent $BaSO_4$; the recovery was 68.2 per cent. Combining of these individual table concentrates with Spigot 1 results in a product containing 96.0 per cent $BaSO_4$, and the overall recovery is 89.6 per cent of the total barite in the original ore.

It will be noted that of the three ores tabled, two were badly contaminated with fluorite. The third contained an extremely high percentage of silica but was almost free from other contaminants. An effective removal of the fluorite could not be accomplished except at a rather high loss of barite in the tailings. The recoveries of barite from Ores C and D were 68.1 per cent and 78.8 per cent, respectively, of the total barite in the original ores, the fluorite analyses of the corresponding concentrates being 1.8 and 1.4 per cent. Table treatment of the high silica ore, K, however, was quite successful, especially with regard to removal of the silica. The recovery of barite was not particularly high, being 89.6 per cent of the total barite in the original ore.

Froth Flotation — A preliminary report on this phase of the investigation was published in 1936, and the following discussion, including Table V, is based to a great extent on that report.[3]

Flotation tests were made on Ores C, D, E, F, G, H, I, and K. Ore F is a final concentrate from a mill treating ore of the high iron type. After washing, screening, jigging, and tabling, the concentrates from this mill are still too high in iron for certain uses. Ore E is of such low grade that it was impossible to produce salable barite concentrates; therefore, the results are not included. The prior selective flotation of the galena, however, offered no problem other than an additional middling loss of barite.

The samples were ground in a porcelain mill with flint pebbles. Flotation was done with distilled water in a 250-gram homemade machine of the minerals separation type. The rougher concentrates were cleaned in the same cell.

Two reagent charges were used, one for ores F, H, and K (not containing fluorite) and the other for ores C, D, G, and I (containing fluorite), as in Table VI.

Table VI—Pounds Reagent Per Ton of Feed

	Ores F, H and K	Ores C, D, G and I
Sodium silicate	1.0	1.0 to 1.25
Sodium oleate	0.3	..
Oleic acid	0.5	..
Emulsol X_1	..	0.5

The reagent charges have been interchanged, but the emulsol charge appears less satisfactory for ores F, H, and K, and the oleic acid charge is wholly unsatisfactory for ores C, D, G, and I.

With either set of reagents the ore was first conditioned about half a minute with sodium silicate. The other reagents were then added to the cell, conditioned a short period and the rougher concentrate was floated. One to three cleaners were required. In some cases sodium silicate was used in cleaner runs, whereas in others no reagents were required. Flotation results are shown in Table V.

The flotation of the high-iron ore and the high-silica ore was controlled easily and permitted considerable leeway in manipulation. The ores containing fluorite are somewhat more sensitive. On these ores concentrates have been recovered that assayed higher in $BaSO_4$ and lower in $CaCO_3$ than those shown in Table V, and it is not improbable that the results can be improved. Various tests were made to recover the fluorite after the barite and to float the fluorspar first and then the barite. These results were not superior to those of other investigators and are not included.

Results indicate that the Southern barite ores of the type tested are amenable to flotation. Reduction of the laboratory tests to practice seems entirely possible in view of the successful work on other non-metallics.

Summary and Conclusions

The feasibility of concentrating low-grade barite ores of the Southeastern States has been investigated. Two methods of concentration were tried; namely, classification and tabling and froth flotation. The ores studied were contaminated with one or more of the following impurities: silica, fluorite, iron oxide, and calcite. Only the ores from Bibb County, Ala., contained appreciable amounts of calcite. Likewise, the only ore badly contaminated with silica was one from Kings Creek, S. C.

Classification and tabling cannot be considered applicable to the removal of iron oxides from barite, due to insufficient difference of specific gravity between such minerals and the barite. In the case of the ores that

[3] O'Meara, R. G., and Coe, G. D.: "Froth Flotation of Southern Barite Ores." Trans. A.I.M.E., Tech. Pub. 678, February, 1936.

contained fluorite and calcite as the principal contaminants, these being ores from Bibb County, Ala., classification and tabling gave fairly good elimination of the fluorite and calcite at low recoveries of barite, say in the range of 68 to 80 per cent of the total barite in the original ore. Such recoveries, however, would probably be too low for satisfactory commercial operation. One ore from Stackhouse, N. C., contained fluorite so intimately mixed with the barite that only by grinding to a size too fine for successful classification and tabling could it be liberated from the barite. The only ore that gave satisfactory results by classification and tabling was the high-silica ore from Kings Creek, S. C. This ore contained 73.7 per cent $BaSO_4$ and 22.0 per cent silica, but classification and tabling gave a concentrate analyzing 96.0 per cent $BaSO_4$, the recovery being 89.6 per cent of the total $BaSO_4$ in the original ore.

Froth flotation is much more generally applicable to the concentration of low-grade ores than classification and tabling, as far as actual metallurgical results are concerned. All of the types of ore studied in this investigation were subjected to froth-flotation tests. The most difficult ores to treat by flotation were two from Bibb County, Ala., containing high percentages of both fluorite and calcite. Although the concentrates from these ores showed a fairly satisfactory $BaSO_4$ content, the recoveries were low—in the neighborhood of 80 per cent. Flotation results on ores containing silica and iron oxides as the principal contaminants were excellent, showing almost complete elimination of these impurities, with high recoveries of $BaSO_4$.

On the basis of the foregoing discussions some general deductions can be made regarding the adaptability of classification and tabling and froth flotation to concentration of low-grade barite ores. In the case of ores contaminated with fluorite, calcite, or silica, or a mixture of these impurities but with iron content low enough to be disregarded, a combination of the two methods of concentration would ordinarily be more advantageous than either method by itself. After the ore is crushed to tabling size and classified, the spigot products could be tabled and the classifier overflow, which is too fine to be tabled efficiently, could be treated by flotation. In exceptional cases, where the impurities are too intimately mixed with the barite to be liberated by crushing to tabling size, approximately 28 or 35 mesh, it would seem logical to grind to the necessary fineness and then treat all of the ore by flotation. Ores that contain iron oxide minerals as one of the impurities to be removed are not apt to be amenable to classification and tabling, but flotation should give excellent results in the elimination of iron minerals.

A consideration of the feasibility of concentrating low-grade barite must take into account the suitability of the concentrated product for commercial use. It is essential to know whether the concentrates would meet the consumer's specifications both as to chemical and physical properties. In the course of this investigation it has been difficult to get reliable and definite information as to the exact requirements of the consumers. The authors have been informed through private correspondence with one of the largest producers of lithopone in this country that "barite containing even traces of fluorite" is unsuitable for use in his lithopone process. Whether this would apply to barite used in the manufacture of chemicals is not known. It is quite possible, however, that the only outlet for barite or barite concentrates containing as much as one-half of 1 per cent of fluorite would be the ground-barite market. In the case of ground barite, the color is important, and bleaching is quite often resorted to in order to meet specifications. In barite to be used in lithopone manufacture, a product containing a large percentage of material below 100 mesh would be objectionable from the standpoint of handling and roasting. In view of these factors it appears that concentrates from a barite ore containing fluorite in appreciable amounts would have to be disposed of in the market for ground barite. Concentrates produced from low-grade ores containing no fluorite probably could be sold for lithopone manufactures after removal of the fines. The fines would have to be dried and disposed of in the market for ground barite.

TABLE V—Flotation Results

Ore C—Containing fluorite and calcite. Minus 100-mesh grind.

Product	Weight, per Cent	Assay, per Cent			Distribution, per Cent		
		$BaSO_4$	CaF_2	$CaCO_3$	$BaSO_4$	CaF_2	$CaCO_3$
Cleaner concentrate	63.2	94.0	2.1	1.9	82.3	8.0	13.8
Middling	8.8	64.6	18.0	14.4	7.8	9.5	14.5
Rougher tailing	28.0	25.4	49.2	22.3	9.9	82.5	71.7
Feed (composite)	100.0	72.2	16.7	8.7	100.0	100.0	100.0

One cleaner was used with 0.2 lb. sodium silicate per ton of original feed.

Ore D—Containing fluorite and calcite. Minus 65-mesh grind.

Cleaner concentrate	69.2	94.3	0.8	3.4	80.0	7.3	26.7
Middling	8.1	76.2	2.1	12.4	7.6	2.2	11.4
Rougher tailing	22.7	44.7	30.5	24.0	12.4	90.5	61.9
Feed (composite)	100.0	81.6	7.6	8.8	100.0	100.0	100.0

One cleaner was used with 0.2 lb. sodium silicate per ton of original feed.

Ore I—Containing fluorite. Minus 200-mesh grind.

Cleaner concentrate	84.6	97.6	1.6	0.5	87.4	32.5	72.2
Combined middlings	9.2	84.2	13.5	0.9	8.2	29.5	14.3
Rougher tailing	6.2	67.6	25.5	1.3	4.4	38.0	13.5
Feed (composite)	100.0	94.5	4.2	0.6	100.0	100.0	100.0

Three cleaners were used each with 0.2 lb. sodium silicate per ton of original feed.

Ore F—Mill concentrate high in iron. Minus 65-mesh grind.

Product	Weight, per Cent	Assay, per Cent		Distribution, per Cent	
		$BaSO_4$	Fe_2O_3	$BaSO_4$	Fe_2O_3
Cleaner concentrate	92.2	98.6	0.1	98.4	6.4
Middling	1.4	54.4	12.2	0.8	9.8
Rougher tailing	6.4	11.5	22.8	0.8	83.8
Feed (composite)	100.0	92.4	1.7	100.0	100.0

One cleaner with no reagents was used.

Ore H—Ore high in iron. Minus 65-mesh grind.

Cleaner concentrate	77.2	98.1	0.6	88.9	4.3
Combined middlings	9.0	77.5	13.9	8.1	11.7
Rougher tailing	13.8	18.7	65.1	3.0	84.0
Feed (composite)	100.0	85.3	10.7	100.0	100.0

Two cleaners with no reagents were used.

Ore G—Ore containing iron oxide and fluorite. Minus 65-mesh grind.

Product	Weight per Cent	Assay, per Cent			Distribution, per Cent		
		$BaSO_4$	Fe_2O_3	CaF_2	$BaSO_4$	Fe_2O_3	CaF_2
Cleaner concentrate	72.9	96.8	0.4	0.2	81.2	7.3	2.0
Middling	10.2	87.8	4.5	4.1	10.3	9.1	7.5
Rougher tailing	16.9	43.9	24.9	30.1	8.5	83.6	90.5
Feed (composite)	100.0	86.9	5.0	5.6	100.0	100.0	100.0

One cleaner with no reagents was used.

Ore K—Ore high in silica. Minus 65-mesh grind.

Product	Weight, per Cent	Assay, per Cent		Distribution, per Cent	
		$BaSO_4$	SiO_2	$BaSO_4$	SiO_2
Cleaner concentrate	75.0	97.5	0.4	99.1	1.3
Middling	3.0	11.5	74.5	0.5	10.3
Rougher tailing	22.0	1.5	87.2	0.4	88.4
Feed (composite)	100.0	73.8	21.7	100.0	100.0

One cleaner was used with 2.0 lb. sodium silicate per ton of original feed.

—Excerpted from U. S. Bureau of Mines Report of Investigations No. 3376, written by R. G. O'Meara and G. D. Coe, assistant metallurgist and junior metallurgist, respectively, Southern Experiment Station, Tuscaloosa, Ala.